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000 taro had been cultivated on permanent flooded fields earlier than had rice. Another possibility would be that taro, together with the technique of irrigation, was introduced into Oceania later than were the yams and alocasia, and the Polynesians' more important fruit trees.

173 A folktale of the Bontocs in the mountains of northern Luzon furnishes us with another clue. According to Bontoc lore, their hero, Lumaug, taught them agriculture in a tiny irrigated garden, which is still tended from generation to generation by a special priest. The crop of this garden is taro and not rice.¹⁵ This would seem to lend support not only to the thesis that the cultivation of root crops preceded that of grain but also to the thesis that terracing and irrigation were already being practiced by cultivators of root crops.

241 A beautiful example of sedentary cultivation with root crops as a staple has recently been discovered in the remote Grand Valley of the Balim River in the highlands of Netherlands New Guinea. On the valley floor of the Balim and its tributaries neolithic people practice intensive cultivation, including such techniques as the use of green and animal manure, deep tillage with stone adzes, the digging of ditches to improve the run-off and drainage of swampy land, and the construction of terraces.¹⁶ On the slopes they practice shifting cultivation. In both their shifting and their sedentary agriculture the staple crop is the sweet potato, while taro is a secondary crop. Also subsidiary are bananas, sugar cane, and pandanus.

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[137] In most parts of Southeastern Asia, however, root crops have been replaced by such cereals as millet, Job's tears, upland and lowland rice,¹⁷ and maize. There seem to be good reasons to believe that the first cereals cultivated in Southeastern Asia under the system of shifting cultivation were foxtail, also known as Italian millet (*Setaria italica* Beauv.), and Job's tears (*Coix lacryma-jobi* L.). Before their domestication these grasses, like the root crops and fruit trees of Southeastern Asia, had been used by alithic and palaeolithic hunting and gathering people. Shifting cultivators succeeded in domesticating these plants by selecting over the course of years the species most valuable to them. Although foxtail and Job's tears have largely been replaced by the more valuable grains, rice and maize, there are still shifting cultivators in India, Thailand, Indochina, Malaya, the Indies, and the Philippines who raise the former cereals. Burkill says of foxtail,

Such a crop as this probably came into cultivation before man had settled enough to grow the better cereals. Its grain ripens in even as little as two months and a half from sowing, and the wandering tribes of the Malay forests are able to remain in one neighbourhood long enough to catch a crop: but the usual duration of the crop seems to be four months.¹⁸

¹⁵ Keesing and Keesing: *Taming Philippine Headhunters*, 1934, p. 56.

¹⁶ Brass: "Stone Age Agriculture in New Guinea," 1941, pp. 555-569.

¹⁷ Upland rice is also known as hill, mountain, dry-land, or dry, rice; lowland rice is also known as irrigated, wet-land, or wet, rice.

¹⁸ Burkill: *op. cit.*, Vol. 2, p. 1999.

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Probably the grain known as Job's tears was originally domesticated somewhere in the area between India and southern China, and it is still of importance in this area, although maize has competed with it since the latter's introduction into Southeastern Asia in the sixteenth century.¹⁹

RICE, THE BASIS OF THE AGRICULTURAL ECONOMY OF SOUTHEASTERN ASIA

By far the most important grain of both shifting and permanent cultivators in Southeastern Asia is rice, which occurs in the wild state in Africa as well as in various parts of southern Asia. The cultivated species (*Oryza sativa* L.) is probably descended principally from two Asiatic wild rices, *Oryza fatua* Koen. and *Oryza minuta* Presl. *Oryza fatua* is thought to be the dominant ancestral strain. These two ancestors are found in moist places from the Himalaya Mountains to Ceylon and from southern China through Indochina, Thailand, Burma, and Malaya to Java, Borneo, and the Philippines.²⁰ Rice was probably first domesticated in northeastern India, somewhere north of the Bay of Bengal, whence the domesticated varieties have spread in all directions: southeastward through Burma into the Malay-inhabited areas, eastward and northward into Farther India, China, Japan, Formosa, and the Philippines, and westward into the Near East and beyond.

The remarkably large number of distinct varieties of cultivated rice²¹ has been interpreted as evidence of the great antiquity of its domestication. In the course of thousands of years of selection, varieties have been developed that are adapted to a wide range of natural conditions and especially to varying amounts of water. These varieties may be divided into two main classes: upland, or dry, rice and lowland, or wet, rice. The division, based on the two main types of agronomic practice, is not a very sharp one. Some upland varieties can be grown in flooded fields, and some lowland varieties can be grown in dry fields; however, it is said to be easier to grow dry rices in water than to grow wet rices on dry land.²² In general, the areas suitable for the cultivation of upland rice are much more limited than those suitable for lowland rice, which can be grown outside the regions of assured rains, provided that water is available for irrigation; whereas upland rice must be grown in a humid atmosphere with an assured rainfall over a three- to four-month period.²³

Upland rice is grown by the shifting cultivator, into whose economy it

¹⁹ *Ibid.*, Vol. 1, pp. 629-631.

²⁰ *Ibid.*, Vol. 2, pp. 1593-1595.

²¹ According to Copeland (Rice, 1924, p. 131) some 3500 varietal names are known in the Philippines; these may be presumed to describe more than 2000 different varieties; in India, where conditions seem to favor mass mutation, some 8000 varietal names have been recorded, but we do not know how many distinct varieties these represent.

²² Burkill: *op. cit.*, Vol. 2, p. 1595.

²³ Lacking direct evidence, students of rice and its cultivation have frequently speculated on the comparative age of the two types. Some argue that the cultivation of wet rice preceded that of dry rice. They maintain that rice is, by nature, an aquatic plant. There are, however, grounds for thinking that the cultivation of dry rice is the older form. For one thing, there are wild varieties of upland rice.

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fits perfectly, for it does not require a permanent field but can be grown anywhere, on flat land or steep slopes, provided that the rainfall is sufficiently heavy and the temperature and soil are suitable. In contrast, the cultivation of wet rice requires a sophisticated technique. To adapt to agriculture in Southeastern Asia Owen Lattimore's remark on the place of irrigation in Chinese agriculture,²⁴ we may say that the cultivation of wet rice lies at the core of agriculture in Southeastern Asia but not at the very roots.²⁵

The sedentary cultivators of Southeastern Asia have developed not only a notable range of varieties of wet rice adapted to varying natural conditions but also many differing techniques of rice culture, which embody the experience of generations of cultivators. Every important phase of the cultivation of wet rice has many variants. The reasons for these are often hidden to the casual observer, but Western agricultural specialists after painstaking research and experimentation have been forced to concede their value.

The ordinary varieties of wet rice differ greatly in respect to the time required for maturing and the amount of water needed. Selection has led to such remarkable achievements as the development of floating rice and of salt-loving varieties. The floating rice of Thailand and Cochinchina can be grown on land subject to prolonged high floods, a condition that ordinary varieties of wet rice do not tolerate. The growing plants are able to keep up with the rising floodwater; in extreme cases, the stems may reach a length of as much as 12 or 15 feet.²⁶ Salt-loving rices, which can be grown on saline soils or in brackish water, are cultivated along coasts or estuaries.

The raising of seedlings in seedbeds, after which they are transplanted to the field, is the main characteristic of most Oriental wet-rice culture. This practice has given Oriental rice relatively high yields. The preparation of the seedbed itself varies considerably.²⁷ The commonest method of raising rice seedlings is to make the seedbed on thoroughly soaked and puddled ground. Frequently the seed is soaked and allowed to germinate before it is sown in the bed. In the northern Philippines the seedlings are raised in seedbeds that are not flooded and puddled but are left dry. When the seedlings are pulled up from either a wet or a dry seedbed their roots

²⁴ Lattimore: *Inner Asian Frontiers of China*, 1940, p. 312. Elsewhere (p. 29) he says, "To assume the working out of such a technique [irrigated rice-growing] at the earliest stages of cultural and social development implies the ability to take a second major step forward at a time when the first tentative step had barely become possible."

²⁵ In Java, for example, the cultivation of wet rice has spread only relatively recently into Sundaese territory and did not reach northern Bantam until the sixteenth century. Even today the Badoei of West Java have religious scruples against the planting of wet rice as well as against the use of the hoe or of the plow and carabao. Notwithstanding strenuous efforts on the part of the government to induce the Badoei to adopt a more intensive form of agriculture they continue to practice shifting cultivation and in the main to plant upland rice, using the dibble stick. See Kools: *Hoema's*, 1935, pp. 22-23.

²⁶ Tran-van-Huu: "Note sur la culture du riz flottant en Cochinchine," 1920, pp. 46-54.

²⁷ Copeland: *op. cit.*, pp. 226-229.

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7 [Filed in category 253. -- Analyst]

2 [see P. 11, category 116. -- Analyst]

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suffer a certain amount of damage. The seedlings must therefore be given time to grow strong enough to endure the temporary uprooting. They usually need from 30 to 40 days before they are ready for transplanting. Whenever early transplanting is necessary a technique is employed which is known in the Philippines as *depop*. The puddled seedbed is completely covered with banana leaves, which are pressed slightly into the mud so that a thin layer of mud spreads over the leaves. On top of this is placed a layer, an inch thick, of rice hulls or finely cut straw. The whole is thoroughly soaked and sown with seeds. The banana leaves prevent the roots of the seedlings from growing into the ground and suffering the usual damage when transplanted, but the seedlings must be transplanted within two weeks after the sowing of the seed.

In the riparian marshes of Sumatra and Borneo—the *lebak* areas—all the land is flooded at the time when the rice seed should be put into the ground. The inhabitants of these districts, however, have found an ingenious solution to their problem: the floating seedbed. They build small rafts of bamboo, reed, banana stems, or the leaf-ribs of the sago palm, on which they place a layer of rush, or some other aquatic plant, and then a thick layer of fine mud. As the water level rises and falls the seedlings have a chance to develop on the float unharmed.

Numerous also are the techniques employed to supply wet-rice fields with the necessary water (see pp. 47-51). These reflect the nature of the terrain, the social organization, and the stage of technical development of the inhabitants. For it is obvious that the cultivation of wet rice on the plains of the Red River in Tongking would require very different techniques from those required on the steep mountain slopes of northern Luzon.

CULTURE, TYPES OF LAND USE, AND POPULATION PRESSURE

One of the most striking characteristics of Southeastern Asia is the great variation in the density of the population (Map, Fig. 15). This variation reflects differences in culture as well as differences in physical environment. The culture and social organization of a people are intimately linked to their technique and the intensity of their land use, which in turn guide the people in their selection of new land when it becomes necessary for them to seek new homes. The Cambodians, for example, when living in an environment similar to that of the Annamese, do not create the large rural settlements characteristic of areas inhabited by the latter.²⁸ Likewise, the Madurese prefer to settle in small hamlets or in isolated homesteads (*Einzelsiedlung*) and to till unirrigated land, whereas the Javanese live in large villages and are by preference wet-field cultivators. Again, while the Bontocs and Ifugaos of northern Luzon build terraces and cultivate wet rice as their primary crop, the neighboring Apayaos, most of the Kalingas, the Tinggians, and the Gaddangs have so far resisted all attempts on the

²⁸ Gourou: L'utilisation du sol, 1940, p. 94.

000 part of the government and of missionaries to introduce terracing and wet-rice cultivation but, instead, continue to practice shifting cultivation and to depend upon dry rice as their staple food.

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Wherever we find shifting cultivation the density of population is low; on the other hand, permanent cultivation provides the basis for higher densities. The higher the density, the greater is the care bestowed upon the cultivation of the soil. The development of permanent-field cultivation, the construction of terraces on mountainsides and hillsides, the dyking and draining of plains, and other complex techniques associated with wet-rice cultivation are but expressions of a population density that demands an intensive utilization of the soil and a maximum production of food crops.

000 The areas where wet rice was first cultivated were probably hollows and small valleys and the well watered slopes of low hills rather than the great plains and wide valleys that are today the rice granaries of the world. The utilization of extensive plains and broad river valleys for the cultivation of wet rice requires a social organization unknown to the peoples who first began wet-rice culture.

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231 It is thought that the cultivation of wet rice originated in days when the hoe and the dibble stick were the only agricultural tools, that is, before the animal-drawn plow reached Southeastern Asia. The broadcasting of seeds is held to be characteristic of plow culture, whereas the cultivators of wet rice in Monsoon Asia generally plant their rice seedlings in the manner of shifting cultivators,²⁰ a circumstance that would seem to support the hypothesis that the carabao and the plow were not a part of the original technique but were adopted later. Even today wet rice is raised in some parts of Southeastern Asia without the use of the plow. For example, peoples in central Celebes prepare their fields for cultivation by driving carabaos back and forth until the fields are thoroughly puddled.²⁰ In other areas where wet-rice fields are built on such steep slopes that it is impossible to get carabaos to the terraces, farmers are frequently obliged to till their land entirely by hand—employing only such tools as wooden spades and sticks, which may be shod with iron. The Ifugaos of northern Luzon, for example, have terrace walls reaching, in some cases, heights of 60 feet or more that can be scaled only by means of rocks jutting out from the faces of the walls.

000 Although most sedentary cultivators in Southeastern Asia make use of

²⁰ Although rice growers in other parts of the world generally use the broadcast method of sowing, one finds it in Southeastern Asia only as a rare exception. According to Copeland (*op. cit.*, p. 224) the *subog*, or broadcasting method, is used in the Philippines over a rather limited area. This method produces lower yields but its advantages are "some saving of time, saving the labour of transplanting, and the possibility of maturing a crop with less water; rice grown directly in its place can get along with less water than transplanted rice." According to Kruyt ("De To Rongkong in Midden-Celebes," 1920, p. 380), the To Rongkong of central Celebes transplant their wet rice only in exceptional cases but usually broadcast it.

²⁰ Kruyt: "De To Seko in Midden-Celebes," 1920, p. 409.

2 [See pp. 35 ff., category 241 or 116. -- Analyst]

Chapter II

THE SHIFTING CULTIVATOR

[p. 16]

241 The field of the shifting cultivator is known by various local terms. It is
361 called *caingin* in the Philippines, *humah* in Java, *ladang* in the Indies as a
311 whole and in Malaya, *taungya* in Burma, *tamrai* in Thailand, and *ray* in
Indochina.¹ Practically without exception, it is a clearing in either pri-
meval or second-growth forest. The use of grassland is so unusual that
we shall limit the following discussion to shifting cultivation on forest land.

As his name indicates, the shifting cultivator does not use the same
piece of land every year; instead, he kills or cuts down at regular intervals
—every year, every other year, or every third year—the trees of a small
forest patch. He burns as much of the woody growth as is possible or
convenient. Among the charred stumps and half-burned tree trunks he
plants his favorite crops, be they cereals such as millet, upland rice, or
maize; or tubers such as yams or sweet potatoes (Figs. 4-10).² The latter
are planted extensively by the *caingero*, the shifting cultivator in the Phil-
ippines. In planting cereals it is usually the men who take the planting
stick to make little holes and the women who drop in a few seeds, using
their feet to cover the seed with soil (Figs. 11-13).³ As forest land is
generally free from weeds or grasses and the soil is usually rich in humus
and well supplied with the ash of burned plant matter after clearing, it
produces a very good, or even excellent, first harvest; the second harvest
begins to show a decline in yield, and thereafter the returns diminish
rapidly.² Grasses and weeds invade the clearing. Rather than battle these,
the peasant abandons his old *ladang* and cuts and burns a new patch of
forest (Fig. 13).⁴ The old plot reverts, under favorable conditions, to second-
growth forest, the so-called *bluhar* of the Malays, and is not cleared again
for a period, the length of which may vary from 8 to 15 years, or more.

Shifting cultivation is characterized by a lack of tillage; the soil is
hardly disturbed, as no plow turns it. There is less labor involved than in
other methods of cultivation, and the work is more evenly spread over the
year—an advantage where labor is relatively scarce. The tasks involved
are cutting, burning, and planting; sometimes simple fencing of the field
against animals, guarding—especially before the harvest and usually by
women and children—and, finally, harvesting. In addition, there may be
some weeding in the first year and certainly during the second.

¹ In British India *jhum*, *kumri*, *d'hya*, *brumar*, or *duller*; in Ceylon *chemu*; in Japan, Korea, and Formosa *karen* (a Japanese term); in Central America *milpa*; in parts of Africa *chitemene*.

² Danhof reports for parts of the Lamoeng Districts that a *ladang* will produce from 15 to 25 quintals of rice in the first year and approximately 5 in the second year. In areas where the second yield shows such a serious decline the peasants usually prefer to make a new *ladang*—Danhof: "Bijdrage," 1940, p. 199.

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lanzones, papayas, and chicos, which find a good market in Manila, but on the whole we rarely meet in the Philippines such intensive garden culture as in Java. The diet of the average Filipino is not well balanced and is particularly deficient in fruits and vegetables. In recognition of this fact the Bureau of Education and the Bureau of Plant Industry have both done much to impress the peasants with the need for fruit and vegetable gardens. Although the situation has improved during the past forty years and a large variety of fruits is now produced, the country still depends upon imports, whereas with a little effort most of the imported fruits could be produced locally and would furnish an additional source of income. It would be well to encourage the peasants to grow more fruits and to advise them on the most suitable varieties. In the other countries of Southeastern Asia, also, with the possible exception of Java, such advice would be valuable.

The published material available on the importance of gardens in Indochina is similarly limited in quantity. Even Gourou in his study of land utilization restricts himself chiefly to listing the fruits and vegetables found in the gardens and to stating that certain districts are renowned for the quality of their garden fruits. Gourou's list of fruits and vegetables is as varied and extensive, however, as similar lists for any of the other countries of Southeastern Asia.

WET FIELDS

Throughout the countries bordering the South China Sea most of the cultivated land is used for the growing of lowland, or wet, rice. For this purpose the fields must be leveled and surrounded by earth dams to impound rain water during the rainy season or to confine the water that is carried to the fields through irrigation canals or lifted to the fields by mechanical means. If a field is properly leveled the surrounding dyke will keep the water everywhere at the same depth. The size of the wet-rice, or paddy, fields, and the amount of labor that is required to make them, depend upon the topography of the region. In the lowlands, where no terracing is required, there is relatively little labor involved in the making of paddies, which are frequently large. A hilly, or mountainous, terrain necessitates terracing, which demands greater effort and reduces the size of individual fields; the steeper the slope, the narrower the paddies. We have only to see the rice terraces of the mountains of northern Luzon, southern Bali, the Preanger districts of West Java, or Sumatra's West Coast in order to realize how much effort has been expended in building these terraces and how much energy must be devoted to their upkeep. The terraces, as well as the wet-rice fields of the plains, represent the accumulated efforts of generations of peasants, each of which has helped to extend the area devoted to the cultivation of wet rice (Figs. 50-58).¹

Not all people show the same skill in the making of paddies. According to Credner, the Thai are quite helpless on sloping land that requires terracing before wet rice may be planted. They would prefer to migrate to a

$\frac{1}{2}$ [see pp. 115 ff. category 116. -- Analyst]

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● 243 184 region where level land is available rather than undertake the terracing of a hillside; on the other hand, they have been successful in building innumerable canals to tap rivers and spread the water over the plains.⁹ However, they do not seem to be able to fight great floods. In contrast, the Annamese of Tongking have built huge dykes against destructive floods and the attack of the sea.

243 The problems presented by the cultivation of wet, or lowland, rice change from country to country, from region to region, and sometimes even from village to village. Lowland rice demands a soil thoroughly soaked with water and worked into "a fine soft mud by hoeing, plowing, trampling, or harrowing, and . . . free from weeds."¹⁰ The field must remain under water until the ears of rice begin to fill and harvest time approaches. The amount of water required to grow lowland rice depends upon the variety of rice, the length of its growing period, and the nature of the soil. There are innumerable varieties of lowland rice. One way of grouping them is according to the number of days they take to mature, which ranges from 60 to 300 days. In the Philippines varieties that require less than 150 days are considered early maturing, those that need from 150 to 190 days medium-late maturing, and those needing more than 190 days late maturing.¹¹ The longer the growing period, the greater the water requirements and, generally, the higher the yields. Normally the water covering the field has a depth of from 10 to 15 centimeters. But "floating rice" can keep pace with a slowly rising flood and reach the amazing height of 4 meters or more. The stems settle on the mud when the water recedes, and new roots start at the upper nodes, while the lower parts of the stems rot away. Floating rice is especially well known in Cochinchina, and I have seen it in the Philippines. In 1939 the Department of Economic Affairs in Batavia sent a rice expert to Cochinchina to study floating rice and the possibility of introducing it into southern Borneo.

[654] Lowland rice can be grown on many types of soil as long as a heavy clay subsoil is present to prevent the loss of water through percolation. Copeland states that lowland rice does best in heavy soils that hold water securely, and he adds that it is desirable "that there be, at a depth below the reach of the roots, but not too much further down, an impervious substratum-subsoil or hard-pan."¹² We distinguish between two main types of wet-rice fields: those that depend exclusively upon the rain that is impounded by their dykes, and those that are supplied by an irrigation system and are therefore no longer subject to the irregularities of rainfall.¹³

⁹ Credner: Siam, 1935, pp. 203 and 217.

¹⁰ Wickizer: "Rice and Wheat," 1941, p. 272.

¹¹ University of the Philippines: Handbook of Philippine Agriculture, 1939, pp. 7-11.

¹² Copeland: Rice, 1924, p. 45.

¹³ An important variation of the second type is the cultivation of wet riceland that has been flooded by rivers rising above their natural levels. This mode of cultivation, which is found especially in the residency of Palembang in Sumatra, in southeastern Borneo, in Thailand, and in Indochina, is not so dependable as irrigation because of the irregularities of the river floods.

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Irrigation systems also fall into two categories: peasant irrigation works and technical irrigation works. The former have existed throughout South-eastern Asia for more than a thousand years. In recent times scientifically trained engineers have designed large-scale systems with concrete weirs and locks. Fields solely dependent upon impounded rain water produce one rice crop a year, whereas irrigated fields often yield two crops. If even with irrigation only one crop can be produced, yet the irrigation system assures proper water control, whereas without it irregularities in the course of the rainy season may damage, or destroy, the crop.

Wet fields are protected against erosion by leveling, terracing, and dyking. But how does continued cropping affect the fertility of wet-rice fields? Diverse environments and cultural practices in Southeastern Asia create considerable differences in this respect. Much of the paddy land of the Philippines, Indochina, Thailand, Malaya, and Burma has lost a good deal of its original fertility because the peasants have not used manures, fertilizers, or crop rotation. In many instances, however, soil fertility has been preserved by the mineral matter dissolved in the irrigation water and by the silt deposited on those fields that are supplied with irrigation water coming from streams. The value of the water and silt depends, of course, upon the nature of the parent material from which it is derived. Rivers from a young volcanic region supply much richer water and silt than do those that drain a mountain region consisting of sedimentary rock or granite. For this reason, the Irrigation Service of the Netherlands Indies before making final plans for a new irrigation system takes samples of water and silt carried by rivers at different times of the year. The samples are analyzed in order to determine their influence upon the soil to be irrigated. A river found to be carrying water and silt that would lower the value of paddy land would be eliminated as a source of irrigation water, or its use would be limited as much as possible.

Irrigated fields of which the water supply does not contain minerals in quantities necessary for continuous satisfactory plant growth and paddy land that depends exclusively upon rain, both require other techniques for maintaining fertility. In many regions cultivators cut the rice stems just far enough below the ear to allow bundling. This practice makes possible the return of the rest of the plant matter to the soil. From this it is only one more step to work household refuse into the ground together with ashes of burned rubbish, rice husks, leaves, and manure.

As stable manure is not available in adequate quantities, intensive studies of the application of green manures to the cultivation of rice have been made in a number of countries of Southeastern Asia. A recent article by W. Bally reviews the results of these studies.¹⁴ In a few rice-growing regions the peasants, on their own initiative, have learned to use legumes to improve rice soil. In wet fields the decomposition of green manure takes place under anaerobic conditions, and the final product is ammonia. Since

¹⁴ Bally: "The Employment of Green Manures," 1936, pp. T10-T31.

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rice takes up nitrogen in the form of ammonia, the value of green manures on wet-rice fields is apparent.¹⁵ In the Indies, *Crotolaria* species are the most frequently used green manures, the favored one being *Crotolaria juncea* L.; but *Phaseolus lunatus* L., *Dolichos lablab* L., and *Pachyrrhizus erosus* Urban are also used. The peasants of the Red River delta in Tongking are in the habit of working into the ground the wilted matter of a number of legumes that have been grown primarily for seed. The peasants of the province of Nam Dinh have developed a technique that may be unique. They push handfuls of indigo branches into the ground between the rows of rice a few days after the latter has been transplanted, for they believe that indigo is superior to pig manure or human excreta. In Indochina rice-growers frequently cultivate green manure, especially *Crotolaria* species, on dry fields and carry it to the rice fields at the time when these fields are being prepared for the seedlings. A green manure used exclusively in a few districts of the delta land of Tongking is the small aquatic plant, *azolla*.¹⁶ Certain villages, thanks to favorable circumstances, have specialized in the growing of *azolla* to sell to the surrounding country, while other villages reproduce the plant until sufficient quantities of green manure have been obtained to cover all needs. The life cycle of *azolla* is completed in the months from November to April or May. Only the villagers of LaVan know the secret of maintaining and multiplying the plant during the hot season. They guard this secret jealously since it is the basis of their livelihood.

Further studies are needed to establish which varieties of green-manure plants are best suited to the various environmental conditions. It is important to find plants that grow rapidly and can be sown when the rice is still on the field, just after the water has been drained off to allow the grain to ripen. Experiments should also be made in the timing of the application of green manure. Should it be early, or just before the transplanting of the seedlings? Should it be on dry or on wet land?

Crop rotation also has its place as a means of keeping up the fertility of wet-rice fields. This practice seems to be better developed and more prevalent in Java than in any other country of Southeastern Asia. Extensive areas of *sawah*, as the Javanese call their wet riceland, are planted with dry-field crops such as maize, legumes, and other vegetables during the dry season, a practice that has a beneficial effect upon the soil. This form of double cropping is probably better than raising two rice crops in one year, because—although a different variety of rice is chosen for each season—both make essentially the same demands upon the soil; whereas a peanut crop, for example, grown during the dry season will enlarge the nitrogen content of the soil. In some areas of Java lowland rice is rotated

¹⁵ Imperial Bureau of Soil Science: *Tropical Soils in Relation to Tropical Crops*, 1936, p. 11.

¹⁶ For a map showing the extent of the use of *azolla*, see Gourou: *Les paysans*, 1936, p. 392. For further discussion see Nguyễn-cong-Tiêu: "L'azolla," 1930, B, pp. 335-350 (also in *Proc. Fourth Pacific Science Congress, Java, 1929*, Vol. 4, 1930, pp. 355-370).

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with sugar or tobacco grown under plantation management. But is the high fertility of the soil due to this crop rotation, or is it rather the result of the heavy application of commercial fertilizer and the thorough cultivation of the soil under Western management?

In no country of Southeastern Asia is there so great a variety or so intensive a use of commercial fertilizers as in Japan.¹⁷ In general, the peasants of Southeastern Asia lack money for commercial fertilizers. In Indochina local phosphates are within reach of some of the Annamese, but the costs of imported fertilizers are prohibitive. In Java, although attempts to make possible the use of fertilizers through the agency of public credit institutions were successful in some special instances, not more than one per cent of the cultivated area received any commercial fertilizer in 1939. On the other hand, estimates indicate that more than 1,000,000 hectares of sawah have a phosphate deficiency and that a moderate application of phosphate would augment the yield by 25 to 50 per cent.¹⁸

The Agricultural Advisory Service was able to raise the productivity of wet-rice fields in West Java by about 10 per cent. It encouraged the peasants to use fertilizer on seedbeds, to sow rice more thinly on the beds (thus producing stronger seedlings), and to plant the seedlings in rows so that weeding could be done with a special instrument, the *landak* (Fig. 59). This weeder was developed in Japan. During the years immediately preceding 1939, these improvements in West Java resulted in an increase in output of unhusked rice amounting to 300,000 quintals, or 30,000 metric tons, with a value of nearly 1,000,000 guilders. This shows that some improvements in cultivation may increase production without a great capital outlay.¹⁹

Java may be compared only with southern China and with Japan in the cleanliness of its rice fields. The Filipino does not pay much attention to weeding. The Malayan, Thai, Cambodian, Cochinchinese, and Filipino rice farmers have more flooded riceland per capita at their disposal than the people of Java and can thus afford to cultivate their land less intensively.

Irrigation Problems

Peasant irrigation works usually take care of the fields of only one village or of a small group of people who have joined together for the specific purpose of building and maintaining an irrigation system. These works consequently are small and usually inadequate, but nevertheless they de-

¹⁷ "The chief commercial fertilizers used in Japan are pressed herrings, pressed sardines, dried sardines, other fish cakes, bone meal, soybean cake, rapeseed cake, cottonseed cake, other vegetable-oil cakes, ammonium sulphate, calcium cyanamide, calcium phosphate, and potassium phosphate. Calcium phosphate and ammonium sulphate are probably the most representative chemical fertilizers."—Wickizer and Bennett: *The Rice Economy*, 1941, p. 252, footnote 33.

¹⁸ *Departement van Economische Zaken: Voedselproblemen*, 1940, p. 28.

¹⁹ *Ibid.*, pp. 27-28.

² [see p. 117, category 116. -- Analyst]

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mand respect and admiration for the ingenuity displayed.²⁰ "The serious imperfections which characterize native irrigation works and make rice culture uncertain, particularly in the plains, can assuredly not be charged to the account of these who constructed them."²¹ The weirs, by means of which the peasants raise the water of small rivers, are especially weak. The construction material consists of bamboo, trunks of coconut and other trees, and boulders. At times great bamboo baskets are filled with heavy stones and placed in the river, or large stones are laid loosely across the channel. Where the rivers are wide the people drive two rows of tree trunks into the river bed and fill the space between the rows with whatever debris they have at hand. These weirs frequently break because of river floods as they have no provision for allowing passage of flood waters; yet repair is often impossible for the duration of the rainy season, so that the crop is ruined. Another constructional disadvantage is the open intakes. During floods large quantities of water flow through these and cause an excessive soaking of the fields and damage to the canals. Whenever a canal has to cross a depression, a road, or another watercourse, bamboo or hollowed tree trunks are used to carry the water overhead. This often leads to large losses of water, especially during floods. Poor drainage is another weakness of peasant irrigation systems.

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Scientifically trained engineers have come to the aid of peasant communities in Southeastern Asia and have designed irrigation systems based on technological principles and free from the weaknesses of peasant irrigation works. One of these technical irrigation systems may take care of tens of thousands of hectares of riceland belonging to hundreds of villages. In many instances the engineers have improved existing peasant irrigation works; more often they have made irrigation possible where peasant communities did not have the financial and technical resources to overcome natural obstacles. Technical irrigation works are usually government-financed.

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In the Philippines most of the wet-rice fields are dependent exclusively upon the rain that falls directly on them. One centimeter of rain a day is said to be necessary for a healthy rice growth. But there is always the possibility that, particularly in the months of May and June, there may be so little rain that the peasants cannot prepare their fields. A shortage of rain in October is also dangerous as it may seriously damage, or even destroy, the crop, even though the precipitation during the rainy season may have been enough for the production of a satisfactory crop. To guard against an insufficiency of water for the wet-rice crop, therefore, the fields should be supplied by irrigation systems. The Philippines, however, do

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²⁰ The *subaks* of Bali are agricultural cooperative societies that have been formed to construct, maintain, and administer irrigation systems. The achievements of the Balinese *subaks* are very remarkable in a number of ways. Thus, the men of certain villages are especially skillful builders of irrigation works and are able to construct long canals and even tunnels of considerable length. These men are hired by the *subaks* and help them to solve their irrigation problems.

²¹ Van der Meulen: "Irrigation in the Netherlands Indies," 1940, p. 146.

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maize has become unprofitable, and many peasants have changed over to cassava, which makes lesser demands upon soil fertility. The per acre yields of cassava are high, and the plant is a source of carbohydrates, fat, and protein. From the standpoint of dietary needs, however, the ratio between carbohydrates on the one hand and protein and fat on the other is unfavorable. People who live on cassava merely fill their stomachs. The insufficiency of protein intake is detrimental to their health. Table IV compares the chemical composition of cassava, maize, wheat, and rice.

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Maize, as the table indicates, compares quite favorably in protein content with wheat and rice and is especially rich in fat. It has gained an important position in the diet of the people of central and eastern Java, Madura, the island of Cebu, and the Cagayan Valley in the island of Luzon. Both maize and cassava are easy to store and therefore have a great advantage over sweet potatoes, which must be consumed soon after they ripen.

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In Thailand maize is an important crop on the Khorat plateau and in other regions where dry land is available. Among the root crops cassava has gained a greater importance than taro and yams. The last two are grown mainly by Chinese gardeners in the neighborhood of large towns. Cassava, too, is grown commercially by Chinese, especially near the railroad on the peninsula.

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Most of the so-called dry-field crops are grown in Indochina during the dry season on land that is flooded during the rainy season and at that time produces rice. Gourou has estimated that in Tongking 100,000 hectares of land are used exclusively for the production of dry-field crops and that 350,000 hectares of irrigated land are occupied by such crops during the dry season.⁶⁶

This practice of growing dry-field crops on irrigated land during the dry season is especially widespread in Java, where population pressure is so great that the peasants have to use every possible means to enlarge their food supply. If there is not enough water available to grow a second wet-rice crop, they will always try to get a second harvest of quick-growing dry-field crops during the dry season.

In contrast to the peoples of Java, the Filipinos do not, as a rule, go in for the raising of dry-field crops on wet riceland during the dry season, although this should be possible if the land were cultivated. There is enough water in the soil a short distance below the surface for the growing of crops practically everywhere during the dry season. Repeated tilling would keep the soil soft and fine so that water could move upward by capillary action to replace that which is lost through evaporation. Cultivation would enable plants such as maize, peanuts, and soy beans to grow on land that otherwise would be baked dry and hard. Although the ratio between cultivated land and population in the Philippines does not make a dry-season crop a necessity in most regions, there are a number of districts where the peasants traditionally raise a dry-season crop on irrigated

⁶⁶ Gourou: Les paysans, 1936, pp. 407-408.

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may be found. The oldest cash farming of Southeast Asia was the spice trade of the Moluccas, but even at its peak that trade involved very few areas given over exclusively to spices, which for the greater part were collected from farmers each with a tree or two, rather than a number of acres devoted to a crop of spices. The crux of the matter at that period was that nothing cultivated in Southeast Asia apart from spice was transportable to or of use to the world's population centres overseas. To a large extent over the present millennium Southeast Asia has been an absorber rather than a supplier of goods or commodities; only in the last hundred years or so has the condition changed, not so much by new demands for Southeast Asia products as for crops transferred to Southeast Asia for production. 241

Rice.—Commercial agriculture in the whole region occupies about 35 million acres and has taken two forms, both strongly influenced by European interests: farming food crops for sale, and farming non-food crops for sale. Of the food crops, sugar was the earliest successful innovation established in Java and the Philippines soon after European colonisation began, and intended for export to Europe. Today at least half the area devoted to crops grown for export is in rice and, taking into account the amount of rice grown for cash sales in deficit regions inside each territory, the proportion may reach as much as three-quarters. Upon commercial rice production depends the possibility of workers leaving their own farms and devoting their full time to non-food cash crops, so that the workers on rubber, cotton, hemp, coffee and sugar plantations have provided a great demand for Asia's staple cereal, supplies of which have been vital to the development of plantation and mining industries of Southeast Asia and, incidentally to the industrialisation of other parts of Asia. The bulk of the rice produced in Southeast Asia for export has gone to India and China, where a condition approaching the limit of rice-growing has been reached, and to Malaya and the Outer Islands of the East Indies. Japan too was becoming a major rice importer until 1941. All this rice export came from Burma, Siam and Indochina in that order of importance, territories which have pioneered in rapidly expanding commercial rice production to form the pool, the only rice-pool in the world, from which other areas have made up their deficits. Moreover the commercial production of rice in Southeast Asia has been steadily increasing over the last 20 years—the average 243 •

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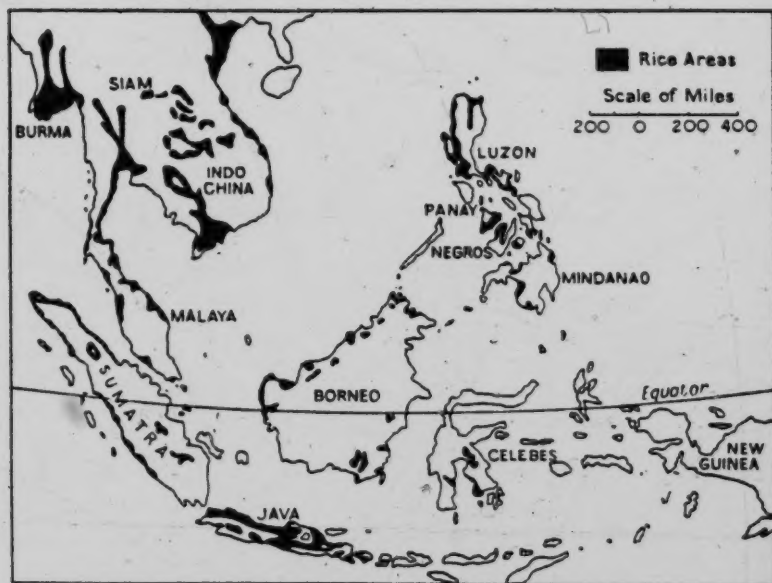


FIG. 112.—Distribution of Rice Cultivation in Southeast Asia

Southeast Asia acreage under rice each year of 1916–20 was 38.28 million, and each year of 1936–40 was 51.40 million. These figures of course include both subsistence and commercial production of rice, but they make it clear that by far the most important farming interest was rice, which covered nearly 95 per cent of cultivated land in Siam, 85 per cent in Indochina and 65 per cent in both Burma and the Philippines.

SOUTHEAST ASIA AREAS UNDER RICE (million acres)

	1914-15	1919-20	1924-25	1929-30	1934-35	1939-40	1944-45	1949-50
Burma	10.0	10.5	12.1	12.8	12.7	12.8	8.5	9.0
Indochina	10.4	11.9	11.7	14.0	13.1	14.7	14.1	12.0
Siam	5.0	6.1	6.8	7.5	8.1	8.8	5.5	12.4
Malaya	—	—	.6	.6	.7	.8	.7	.9
Java and Madoera	6.9	8.8	8.7	8.8	9.9	10.1	7.7	9.7
Philippines	2.7	3.6	4.2	4.4	4.9	4.9.6	3.6	5.7

SOUTHEAST ASIA RICE PRODUCTION (million metric tons clean rice)

	1914-15	1919-20	1924-25	1929-30	1934-35	1939-40	1944-45	1949-50
Burma	3.73	3.74	5.15	5.07	4.6	4.73	2.4	2.9
Indochina	4.32	2.96	3.54	3.67	3.4	4.00	3.6	3.6
Siam	1.93	1.41	3.08	2.41	2.86	2.86	—	3.7
Malaya	—	—	.24	.16	.33	.34	—	.4
Java and Madoera	2.88	3.64	3.43	3.38	3.54	4.09	3.5	4.2
Philippines	.05	1.02	1.28	1.44	1.28	1.5	1.1	1.6

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Cash farming for rice is the only extension of a Southeast Asia subsistence farming crop into commercial farming on a large scale; only a negligible proportion of coconut-growing is for export, though this too, is an extension of Southeast Asia subsistence farming. It has been inevitable that subsistence farmers and the techniques they developed for rice have set the character of commercial rice farming which has been pioneered by local people and continues to be essentially a non-mechanised produce whose volume comes more from area and less from intensive farming.

RICE IN SOUTHEAST ASIA:
ANNUAL AVERAGES PER QUINQUENNium

Period	Million Acres Under Rice	Production Million Tons Clean Rice	Net Exports from S.E.A. (Million Tons Clean)	Per Cap. Utilisation (kgms.)	Yield in Tons per Acre
1916-20	38.3	13.5	3.9	119	.352
1921-25	43.6	15.3	4.6	137	.352
1926-30	47.5	16.5	4.7	131	.348
1931-35	49.6	16.7	5.2	117	.337
1936-40	51.4	17.5	5.0	118	.339
1946-50	48.1	15.6	1.9	98	.325

For 1951 it is estimated that Southeast Asia sowed about 50 million acres of paddy, probably producing 16 million tons cleaned rice. The exports may total 3 million tons. These figures suggest the consumption had declined to below 100 kgms. per person, but this is not reliable since unreported dealings were going on and reported facts were not necessarily the true ones.

Other Food Crops.—The other commercial food crops, sugar, coffee, tea, cinchona and oil palm total much smaller areas than rice farming. Broadly, these innovations were developed by European colonial planters opening up what were very largely virgin territories, normally in the form of large estates calling for a labour force which derived only in part from local people, the rest being obtained by introducing labour from outside. In the Philippines and in Java the first European essays in agriculture caused serious interactions on local land customs; in Siam an aristocratic feudal system enabled commercialisation to be introduced without external intervention. These crops tended to be perennial cultivations, taking advantage of the continuous growing season of the region. In due course this has led to a large production, causing the external price to drop, especially as there has

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external events and their effects on rubber price, to a degree not paralleled by other types of Southeast Asia farming which were, during a crisis, more closely related to subsistence farming and thereby buffered from external valuations.

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TRENDS IN AGRICULTURE

Several long-term tendencies in these various farming types have become apparent. For all the commercial crops except rice, external events have obliged experiment and development towards higher and higher production per unit area; yields for commercial crops have progressively increased. In rice farming, however, methods have continued to be extensive, yields have steadily decreased and there has been little advance in either maintaining fertility standards or increasing the yield. Experimental farms exist throughout the territory to promote these improvements, but they have made little impression on the rice-farming community as a whole.

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RICE YIELDS IN SOUTHEAST ASIA (hundred lbs. milled per acre)

	1934-35	1939-40	1944-45	1949-50
Burma	8.2	8.4	6.5	7.0
Indochina	5.7	5.5	5.6	6.6
Siam	9.1	8.6	7.5	6.6
Malaya	9.7	9.1	—	10.7
Java and Madoera	9.3	10.0	—	9.5
Philippines	5.8	5.8	6.8	6.6

By the quinquennium 1936-40 annual yields had declined nearly 4 per cent from those of 1916-20 and production had increased solely by increasing the acreages, whose annual average for the same quinquennial periods increased by 34 per cent.

The general movements of rice in Southeast Asia are evident from the table on page 356 which summarises surpluses and deficits over a period.

Commercial rice production was associated almost exclusively with the expansion of agriculture to the deltas of the Irrawaddy, Chao Praya and Mekong and in varying degrees to increased control over flood waters. It is in this large-scale water control that the greatest long-term changes have been set going by western engineering techniques coping with the wide range of circumstances under which Southeast Asia floods occur. Effective

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243 small-scale water-control methods had in fact existed in this region before; the earlier technological interest was to expand rice production by increased water-control on specially fertile, generally volcanic, upland soils. The objective then and now was the same—to cultivate the most fertile areas; the difference was that the volcanic soils attracted local attention and were within the capacity of local people, considerably earlier than the deltaic soils.

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SOUTHEAST ASIA RICE EXPORTS AND IMPORTS
(million metric tons clean)

	Exporters			Importers		
	Burma	Indochina	Siam	East Indies	Malaya	Philippines
1915	2.12	1.09	1.0	.55	—	.22
1920	2.0	1.09	.25	.22	—	.07
1925	3.32	1.33	1.18	.50	.41	.10
1930	2.95	1.02	.93	.62	.60	.01
1935	2.93	1.52	1.38	.36	.48	nil
1940	2.50	1.40	2.00	.06	.70	.1
1950	1.17	.09	1.48	.28	.50	.16

A further process at work has been a decline in Southeast Asia consumption of rice per person over the last 30 years, which made possible the expanding exports of rice at a time when population was rapidly increasing. The declining consumption seems to be due to slight changes in diet habit; maize, potatoes and tapioca have steadily entered into local meals and the proportion of vegetables has increased, more especially as it has come to be realised that the dietetic value of meals exclusively based on rice, the custom in Southeast Asia for a long time, is low, as indicated by the small stature and delicate bones of Southeast Asia peoples.

245 Commercial agriculture has largely revolved round tree cultivation (arboriculture rather than agriculture) in which the continuous growing period produces maximum effects. In this tendency may be seen a return to the tree vegetation which is indigenous to equatorial Southeast Asia, and away from the annual and deciduous plants more suited to ecologies associated with the seasonal margins of the tropics. Labour difficulties too are eased to some extent by tree crops whose periodicity is better spread than in the case of annual crops. To the labour difficulty also is due the trend towards devolving arboriculture from plantation systems

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241 that about one-third of its prewar estate area was being tapped in 1947, representing two-thirds of the area tappable.

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In the food crops, surplus margins were more slowly restored. Exports of Southeast Asia rice totalled about a million tons during 1946, as against a combined export of 5.7 million tons annually for 1936-40. The drop in production of this staple was greatest in the case of Burma because there the dislocation by war had been greatest, but by the 1946-47 season, about two-thirds of Lower Burma rice acreages were back in cultivation, as against half in 1945-46. In Cochinchina over 70 per cent of the rice area was being cultivated in 1946-47. Siam which was untouched by military campaigns reported 10.6 million acres under cultivation in rice for 1946-47 (22 per cent more than 1939-40)—the only territory to show a substantial increase of rice acreage in the immediate postwar years.

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A postwar feature has been the general decline in rice yields, mostly an effect of loss of draught cattle, though to report low yields was a convenient cover for black market sales. The consequence of lost production in local food was felt more in places like Malaya which has specialised in non-food commercial agriculture, than in any other territories of Asia, which customarily needed to import only a small margin and not the majority of their rice. For the Philippines in 1947, the United Nations reported that *per capita* consumption of rice was actually higher than in 1939 by about 5 per cent.

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Since labour shortage has been prominent as a factor operating against postwar commercial agriculture, the subsistence farmer and the diversified smallholder have assumed far greater significance than before. Over 55 per cent of Malaya's rubber production for 1946 was from smallholders, a proportion which had been as much as 85 per cent in the early months of that year, yet fell to 45 per cent in 1950 (cf. 39 per cent in 1940).

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The vegetable oils soon came back into production and by early 1947 monthly production in Southeast Asia was not far short of 1941 production and now exceeds it.

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The general lowering of food acreages and of yields, combined with the enforced reversion to subsistence agricultural forms, has a special significance for Southeast Asia food supplies over the next few years, because the restricted food supply comes at a time when population is rapidly increasing, at the rate of about 20

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SOUTHEAST ASIA NUTRITION DENSITIES
(Average number of persons per rice-acre per annum)

Quinquennium	Burma	Indo- china	Siam	Java and Madoera	Philip- pines	Malaya
1916-20	1.23	1.75	1.66	4.12	3.13	—
1921-25	1.19	1.67	1.57	4.27	2.67	5.61
1926-30	1.14	1.61	1.57	4.50	2.69	6.13
1931-35	1.19	1.64	1.63	4.60	2.76	6.42
1936-40	1.25	1.63	1.74	4.96	2.79	7.02
1946-50	2.0	2.1	1.6	5.9	3.9	7.2

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Because population and the net production of food have increased *pari passu*, it is important to examine the "nutrition density" (persons per acre under rice) since the surplus for export depends on low internal consumption of the Southeast Asia staple and high internal production. The countries of Southeast Asia pre-war showed considerable differences in nutrition density, from Malaya (the plantation-mining specialist) with 7.2 persons per rice-acre, to Siam (the rice-surplus specialist) with 1.6. Malaya, Java and the Philippines had nutrition densities much higher than the rest of neighbouring countries and in the case of Malaya and Java the nutrition density had been steadily rising, whereas in Burma, Indochina and Siam it was fairly static. Over the same period, the domestic consumption of rice per person sharply dropped (by 20-25 per cent) in Burma, Siam and Java and rose about 10 per cent in Indochina, Philippines and Malaya. The postwar figures available show considerable increases of nutrition density everywhere except in Siam, yet these were changes of degree, not of pattern.

CHANGING INTERNAL EMPHASIS

Today the very crowded places are firstly, Middle and North Java, Lower Siam and the Red River Delta, where densities of over 1,500 people per square mile occur, with secondary crowdings in Lower Burma, the Lower Mekong, Central Luzon and the Visayas. These concentrations of people are pre-eminently in agricultural areas (Fig. 116), and they are in fact largely made possible by exceptional soil qualities within an area whose general soil fertility is low. These crowded areas have taken part in a commercialisation of local agriculture and their subsequent history has been firstly a

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654 their attention. When, therefore, economic development is advocated on the ground that it provides funds for economic services, it is well to enquire how far these services are concerned with native rather than with western enterprise, and how far they do in fact make native enterprise more efficient. Information on such matters is not readily obtainable, but some light is thrown on them by a recent study of Malaya.

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654 Formerly the natives of British Malaya cultivated little but rice. Conditions did not favour the growth of a large export market such as stimulated cultivators in other parts of Indo-China to extend their holdings, and the Government tried to encourage the cultivation of rice by regulations making it compulsory. In the early years of the present century, when the doctrine of efficiency was beginning to replace the principle of *laissez-faire* as the motto of colonial rule, an agricultural service was created. This included a paddy experimental station, but no one was appointed to specialize in rice, and experiments in the improvement of rice cultivation were discontinuous. About the same time plantation rubber was coming into favour, and the agricultural experts 'gave most of their time to the European and Chinese rubber planters'. Malays also found rubber profitable, and tended to substitute rubber for rice. Thus, with the influx of many hundred thousand coolies to the mines and plantations, the country became increasingly dependent on imported rice. When the war of 1914 and post-war developments stopped these imports, the Government had to import rice and lost £42 million on the transaction, while the estates and mines also lost heavily on importing rice for their coolies. 'The result of this experience was the decision that rice cultivation must be increased and more attention paid to native agriculture.'¹

2 Accordingly the regulations for compulsory rice cultivation were enforced more stringently, and experiments were undertaken with a view to make it more profitable by improving the yield. Under the latter head progress was slow, as frequent changes in the agricultural staff hindered continuity of policy. By about 1925, however, the agricultural department claimed to have discovered new varieties that would enhance the yield by 30 %. This had little effect on extending cultivation, and in 1930 a committee was appointed to examine the situation. It estimated that the area under rice could be more than doubled by the addition of some 600,000 to 1,000,000 acres of potential rice land, but 'there was no one way of making paddy growing

¹ Mills, pp. 250ff.

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profitable and bringing about its extension. The problem must be attacked simultaneously through drainage and irrigation, agricultural betterment and the co-operative department.' One outcome of its recommendations was the reconstitution of the irrigation department in 1932, and the investigations of the new department confirmed the previous impression that 'all over the country padi lands were steadily going out of cultivation. . . . Even in the fine padi plain of Province Wellesley, . . . conditions were steadily deteriorating, the cultivators in debt, and their *kampongs* (villages) often indicating a state verging on poverty.' During the next few years upwards of 40,000 acres were added to the existing irrigation schemes.¹ At the same time, under the influence of the depression there was a fall in the price of rubber, and by 1934 the area under rice had grown by over 100,000 acres.

In the following year, however, with a rise in the price of rubber, the area under rice fell by 35,000 acres. Thus although there was a wide area available for extending the cultivation of rice, and the fall in the price of rubber consequent on the depression encouraged cultivators to prefer rice cultivation, which at the same time was stimulated by compulsion, by extensive new irrigation and by the discovery of more productive strains, yet, with a population that increased between 1926 and 1936 by 29 %, the area under rice expanded by only 11 %.³

*Area under rice*²

(acres, 000)

1924-5	654
1929-30	657
1933-4	767
1937-8	726

This brief survey of the attempts to foster and improve rice cultivation in Malaya suggests that neither compulsion nor the efforts of the agricultural service to enhance production met with much success, and it contains many lessons of general application regarding the relation between economic services and the increase of production. The failure of agricultural experts to increase native production is often explained on the ground that it is difficult 'to persuade a conservative and easy-going peasantry to improve their methods',⁴ and that the economic motive, the desire of gain, does not appeal to 'natives'. This is the easiest and most comfortable explanation of all failures to enhance native welfare; it is their fault and not ours. But it is inconsistent with the facts. While the Malayan was reluctant to grow more rice, he was taking readily to growing rubber. All over the Tropical Far East, native rubber has expanded rapidly, sometimes in the face of opposition. Similarly in Java the opposition of planters and

¹ Mills, pp. 262, 272, 274.² *Ib.* p. 195.³ Wickizer and Bennett, p. 314.⁴ Mills, pp. 251, 259.243
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RICE CULTIVATION IN ASIA

By INEZ ADAMS

243 THE terminology employed by writers discussing Asiatic rice agriculture has raised a problem: are the cultivated varieties of rice distinctly separable into one group that will grow under none but irrigated conditions, and another that demands moderate amounts of moisture but is successfully produced only by dry farming? The terms used in the literature frequently bear this implication. They include references to "wet" and "dry," "dryland," "lowland," "upland" and "mountain" rice. In anthropological studies whose purpose is merely descriptive this creates confusion. When extended to comparative studies and historical reconstructions, with the two methods of cultivation treated as distinct for the conclusions reached, it becomes necessary to examine the distinctions that might justify such use.

101 As early as 1820, John Crawford, writing his "History of the Indian Archipelago," observed that rice is known as "padi . . . in all languages and dialects from Madagascar to the Philippines."¹ He distinguished in Java a "marsh" rice, sown in nurseries and transplanted to flooded fields, and a "mountain" rice, sown in nurseries and transplanted to flooded fields, and a "mountain" or "dryland" rice, grown on arable uplands. These terms remain current. Lowie defines them thus:

243 The innumerable variations of the plant fall broadly into two categories, with corresponding techniques of husbandry. "Swamp" rice can be grown only in marshes or under irrigation. "Mountain" rice yields smaller crops, but can be grown anywhere with normal precipitation.²

Wilhelm Wagner³ speaks in a similar sense of "den gewöhnliche Wasserreis" and "den sogenannten Bergreis," in his account of Chinese agriculture. C. Daryll Forde makes the same general differentiation of cultivated rice falling into two groups due to the physical requirements of the plant. Wissler⁴ mentions "The cultivated varieties known as 'hill,' 'upland,' or 'dryland' rice," in contradistinction to the "aquatic varieties." Keessing,⁵ in one work on the Philippines, employs "wet" and "dry" rice; elsewhere⁶ he speaks of "dry agriculture" in Indonesia, as distinguished from the practice of terracing with irrigation.

E. M. Loeb,⁷ in his general ethnography of Sumatra, notes rice raised in both flooded and dry fields by the Bataks; in the Minangkabau, . . . "wet and dry rice fields are worked together by the men and women . . .";⁸ in Nias, . . . "both the wet and dry variety are grown . . .";⁹ in Atjeh, "Rice is of both the wet and dry variety. The wet rice fields, when not laid in swamps, are irrigated

¹ Crawford, 1820, Vol. I, p. 358.² Lowie, 1938, p. 294.³ Wagner, 1926.⁴ Forde, 1934.⁵ Wissler, 1946.⁶ Keessing, 1937.⁷ *Ibid.*, 1934.⁸ Loeb, 1935.⁹ *Ibid.*, p. 101.¹⁰ *Ibid.*, p. 132.

by rain water which is allowed to trickle down from dams . . .",¹¹ among the Gajo and Alas, "Usually wet rice is cultivated, water being obtained from the rivers . . .",¹² in southern Sumatra, the land is unsuitable for irrigation, so little "wet" rice is cultivated. In a historical note,¹³ Loeb concludes that the Malaysians of Sumatra had learned to grow rice, ". . . at least the dry variety," before the Hindu occupancy. Cora Du Bois¹⁴ believes that "dry" rice was the original staple of the Alorese. With reference to other descriptions, "dry" rice could be severally interpreted as the "dry-weather paddy" described by Scott¹⁵ in Upper Burma; or as the "dry paddy" described in Mysore by Iyengar¹⁶—here referring to a district heavily watered by the monsoon rains, where artificial irrigation is not necessary. It could also be interpreted as the "dry-land" rice used by Fay-Cooper Cole.¹⁷

The Indian Department of Commercial Intelligence and Statistics¹⁸ gives three classes of rice, according to their season of growth. The Philippine Department of Agriculture and Commerce¹⁹ lumps all of the rice as "palay," taking the local variant of the widely used native term "paddy." From Oriental usage, Wickizer²⁰ defines "paddy" as an inclusive term for the growing plants, the harvested stalks, and the threshed, unhusked, grain. Keesing²¹ gives "palay" as the native name for rice on the stalk. Some of the literature extends "paddy" to include irrigated rice fields; in this sense Keesing²² uses it. Wickizer²³ adds that "wet paddy" and "dry paddy" are terms commonly used in Malaya to denote both the system of culture and the product.

The terms "upland" and "lowland" rice are even more current than "wet" and "dry." Verrier Elwin²⁴ uses them in describing the Baiga; R. F. Barton²⁵ for the Mountain Province of the Philippines, and Krieger²⁶ for the Philippines in general. Agronomists who use them include Camus²⁷ in the Philippines, and Jacobson²⁸ in the same area. Pelzer,²⁹ in his recent geographical study, considers them convenient, and Wickizer³⁰ likewise. Camus³¹ adds "mountain" rice to "upland" rice, observing that the same varieties can be grown in both habitats, though some adapt best under the methods of cultivation obtaining in the mountains, others to those used in the uplands. His separation of "upland" and "lowland" rices is complicated by the fact that some of the Philippine "lowland" rices that are grown under irrigation are raised in non-irrigated nurseries or dry farmed previous to transplanting. "Dryland" nurseries for "wet

¹¹ *Ibid.*, p. 224.¹² *Ibid.*, p. 248.¹³ *Ibid.*, p. 301.¹⁴ Du Bois, 1944.¹⁵ Scott, 1911.¹⁶ Iyengar, 1927.¹⁷ Cole, 1945.¹⁸ India Dept. of Commercial Intelligence and Statistics, 1940.¹⁹ Philippine Islands, Dept. of Agriculture and Commerce, 1935.²⁰ Wickizer and Bennett, 1941.²¹ Keesing, 1937.²² *Ibid.*²³ Wickizer and Bennett, 1941.²⁴ Elwin, 1939.²⁵ Barton, 1930.²⁶ Krieger, 1942.²⁷ Camus, 1921.²⁸ Jacobson, 1915.²⁹ Pelzer, 1945.³⁰ Wickizer and Bennett, 1941.³¹ Camus, 1921.

243 paddy" are also described in an official report²² on the Pahang district in Malaya. Ethel Simkins,²³ in an article on the coastal plains of south India, designates "hill" rice, "upland" rice, and "lowland" rice. R. L. Pendleton²⁴ uses "upland" and "lowland" for Mindanao.

Detailed ethnographic accounts, especially those using native classifications of rice, multiply both the varieties and the methods of cultivation. Instances are Albert E. Jenks²⁵ account of the Bontoc Igorot, Ralph Linton's²⁶ of the Tanala, and Newill Parry's²⁷ of the Lakher. These enumerate the native names for the kinds of rice, the dates of sowing and harvest, the number of crops grown per year, the kinds of soil used and their preparation, with other details of cultivation. Parry²⁸ lists fourteen varieties distinguished by the Lakher and Lushai, with native descriptions of each, and of soil preferences. An elaborate but less satisfying description is Grierson's,²⁹ of Bihar. He classifies rice as sown broadcast or transplanted, lists over fifty varieties sown broadcast and over eighty transplanted, then proceeds to state that practice varies with the locality, a variety broadcast in one locale being sometimes treated by transplanting in another. Even if true for Bihar, this distinction would make nonsense elsewhere. Thus, in the Konkan, Ranade³⁰ describes seedlings grown for transplanting in nurseries, that are sown broadcast.

The agronomists have done their best to clear up the confusion.⁴¹ First, as to kinds of rice: O. T. Faulkner,⁴² in discussing West Africa, observes that the terms "hill" or "dryland" rice are deceptive, since all rice (*sic*) yields better in very wet soil. The latter is not a matter of general agreement, but Pelzer says:

The remarkably large number of distinct varieties of cultivated rice . . . may be divided into two main classes: upland, or dry rice, and lowland, or wet rice. The division, based on the two main types of agronomic practice, is not a very sharp one.

²² Malaya, Dept. of Agriculture, 1930.

²³ Simkins, 1933.

²⁴ Pendleton, 1942.

²⁵ Jenks, 1905.

²⁶ Linton, 1933.

²⁷ Parry, 1933.

²⁸ *Ibid.*

²⁹ Grierson, 1926.

³⁰ Ranade, 1927.

⁴¹ Jenkin W. Jones, Principal Agronomist in charge of Rice Investigations, U. S. Dept. of Agriculture, says the following in a letter to the writer:

"It is now generally understood that lowland ('wet') rice is grown on land submerged during a portion of the growing season. The land is submerged either by seasonal rainfall or by artificial irrigation. A large percentage of the world's rice crop—in Asia, Africa, Europe and the Western Hemisphere, is grown in this manner. In much of Asia the lowland (irrigated) rice is transplanted. Some of the lowland acreage also is transplanted in Africa, Europe, and the Western Hemisphere, but in these parts of the world much of it is sown in the same manner as other small grains, and irrigated. Rice grown on land not submerged, for any appreciable period during the growing season, that is, 'mountain,' 'dry,' 'dryland,' and 'hill,' and not provided with levees, dikes or terraced to hold water, now is generally known as upland rice. In my opinion . . . the terms used should be lowland (irrigated) or upland (non-irrigated) rice."

⁴² Faulkner, 1933.

Some upland varieties can be grown in flooded fields; however, it is said to be easier to grow dry rices in water than to grow wet rices on dry land.⁴³ 243

Wickizer⁴⁴ observes that "upland" rice, whatever its variety, is grown without irrigation, i.e., not in surface water; while "lowland" rice of all varieties is grown either under artificial irrigation or in natural swamps where there is standing water at appropriate seasons. Commonly, the varieties grown as "upland" rice are not the same as those grown as "lowland" rice, as they each adapt best to special conditions. A single variety can however often be grown under either system of cultivation.⁴⁵

The kinds of rice set up by the agronomists are thus based upon the plant's adaptations. Hedayetullah⁴⁶ and Copeland⁴⁷ agree in stressing its tremendous adaptability. The latter emphasizes adaptation to varying amounts of water. He classifies as "upland" rice all varieties which are grown without artificial irrigation, but stipulates a considerable range of water tolerance between "lowland" rices. Wild varieties of rice are bearded, as are some cultivated ones, and these reportedly can stand flooding better and for longer periods of time than non-bearded varieties do. Some "lowland" rices grow even in salty water—these are grown in fields visited by the tides, in India, Siam and Annam. Copeland⁴⁸ reiterates Wickizer⁴⁹ to the effect that the "upland" and "lowland" varieties are:

... groups not sharply separated in nature, being blended by many varieties which thrive with or without irrigation; but the division is practical by definition and conforms with agronomic practice.⁵⁰

Wild rice, and many cultivated varieties, shed the seed upon maturity.⁵¹

⁴³ Pelzer, 1945, p. 10.

⁴⁴ Wickizer and Bennett, 1941.

⁴⁵ Jenkin W. Jones states further:

"Lowland (irrigated) rice is more productive than upland (non-irrigated) rice, but land suitable for irrigation plus irrigation water—rainfall and irrigation systems—is limited in all parts of the world. Hence, in regions, particularly in Asia, having relatively high precipitation well distributed during the growing season, upland rice is grown. Upland rice cannot be grown except where the rainfall is rather heavy and well distributed. The varieties grown as upland rice yield more when grown under irrigation, but upland varieties are apparently somewhat more drought-resistant than are lowland varieties. Some lowland varieties, however, have a wide range of adaptation and will yield reasonably well when grown as upland rice."

⁴⁶ Hedayetullah, 1946.

⁴⁷ Copeland, 1924, p. 125.

⁴⁸ Copeland, 1924.

⁴⁹ Wickizer and Bennett, 1941.

⁵⁰ Copeland, 1924, p. 125.

⁵¹ Jenkin Jones notes that:

"Red rice, a cultivated variety, is also the most serious weed in our Southern States. There is nothing unusual about rice shattering; most wild species have this characteristic."

243 In this connection, Copeland⁴² mentions wild rice as the most annoying weed in Philippine rice fields. M. Mène,⁴³ writing in regard to introducing "le riz sec de Chine" to the Midi, notes that it can resist violent winds without shedding its grain or collapsing. Further, the harvest need not be on a fixed date, but is amenable to the grower's convenience. Here, Hedayetullah⁴⁴ points to the duration of the maturation period as a foremost adaptation of the plant to environment. For the early rices, the date varies with the date of sowing; during their growth temperatures do not drop sharply. The transplanted winter rice, India's main crop, ripens when temperatures begin to drop and, despite variation in sowing dates, it matures on almost a fixed day. For cultivated varieties in general, Copeland⁴⁵ gives the range of the growth and maturation period as two⁴⁶ to ten months, remarking that it is an important varietal characteristic. He believes that there is probably an inherited ability to develop at a given rate, but since environmental conditions, such as seasonal fluctuations in temperature and precipitation, cause the period of development to vary also, the inherited limits are obscured.

The altitudinal limit of rice planting in the Philippines is 1500 feet; Wickizer⁴⁷ gives 7500 feet as the limit for "upland" rice in the tropics. Most varieties require four months of hot weather, at a temperature averaging 22°C., without sharp drops from day to night. "Upland" rice thrives at somewhat lower temperatures, "lowland" rice typically requiring two to three months at a temperature of 20°C. during growth.⁴⁸ Rice will not develop normally in shade, and most varieties cannot endure cold nights. "Upland" rice prefers light, loamy soils. Clay soils, which occur widely in the tropics, are well suited to irrigated rice culture, and where a substratum of hardpan occurs, downward seepage is prevented, which may be beneficial provided this is not too near to the surface of the soil. Coraline soils do not hold moisture long enough to raise a crop of "lowland" rice, and the limestones, as in eastern Java, are too porous to permit economical irrigation.

⁴² Copeland, 1910.

⁴³ Mène, 1873.

⁴⁴ Hedayetullah, 1946.

⁴⁵ Copeland, 1924.

⁴⁶ Jenkin Jones comments:

"I have often heard of 60-day rice, but we have had over 8000 varieties of rice from various parts of the world, none of which have matured in 60 days under our conditions. . . . It has been our experience that in Asia at times the word 'plant' is used when 'transplanted' is the term meant; hence, if the rice matures in 60 days from the time it is transplanted, it was 30 to 60 days old when transplanted."

He refers to agricultural experiment stations in the United States, which can nowhere duplicate by any means the climatic, hence growing, conditions in Monsoon Asia.

⁴⁷ Wickizer and Bennett, 1941.

⁴⁸ Jenkin Jones would extend the estimated growing season of "lowland" rice to from three to six months, from his experience in the United States.

Rice has food preferences. It does not require much nitrogen in order to survive, and it will grow in soils that are deficient in calcium and in phosphates.⁴⁹ Wells, Agcaoili and Feliciano⁵⁰ concluded that the chemical content of the grain is influenced by climatic conditions during growth; by type of soil, nature of fertilizers, and seasonal variation. Much⁵¹ has been written about the improvement of the nutritional qualities of rice by modifying such factors as are controllable in cultivation. The plant apparently obtains only carbonaceous elements by photosynthesis from air, sunlight and water. Therefore, according to Albrecht,⁵² the most important factors contributing to the proteinaceous and mineral content of the grain, and hence to its fertility, are soil composition and fertilizers. Transplanting and irrigation cannot supply elements lacking in the soil, though the algal film may make some oxygen available for irrigated rice.

The botanists have made only a beginning in tracing the origin of the cultivated varieties of rice. All ascribe it to one species—*Oryza sativa* Linnaeus. A few advance a polyphyletic origin. Not many surveys have been made in the Old World homes of wild rice. In the New World, the so-called wild rice gathered for food by some American Indians is not a true rice, but is a wild grass known to botanists as *Zizania aquatica*. Of the botanical investigations, Roschewicz⁵³ studies are the most suggestive. Placing the origin of rice cultivation in Asia, he at the same time makes a case for some of the cultivated African rices having originated from wild African species—these akin to *Oryza sativa* L. f. *spontanea*. Further, he believes the latter to be a complex of small independent species. Its center of diversity is very possibly India, where

⁴⁹ Jones states as to food preferences of rice:

"Rice can, it is true, be grown on soils that are low in nitrogen, phosphorus, and potash, but the yields are certainly low also. Kelly has shown that with yields of 2400 to 3600 pounds of rice, 40 to 65 pounds of nitrogen, 26 to 41 pounds of phosphorus, and 60 to 113 pounds of potash per acre are removed. These amounts are not available in poor soils, and hence, yields as large as these are not obtained under such conditions. Rice responds to favorable conditions the same as do other crops . . . nitrogen . . . is most extensively applied to rice land where high yields are produced."

⁵⁰ Wells, Agcaoili and Feliciano, 1922.

⁵¹ See: McCarrison, Robert, "Pathogenesis of Deficiency Disease. XIV—On the Occurrence of Ophthalmia in Pigeons Fed Exclusively on Parboiled Rice and Its Prevention by the Addition of Soil to the Food," *Indian Journ. Medical Research*, 11 (2): 323-335, 1923; "The Relationship of Rice-beriberi in India," *Indian Med. Research Memoirs*, No. 2, 1924; and "Influence of Irrigation on the Nutritive Value of Rice," *Indian Journ. Med. Research*, 15: 915-920, 1928. Also: see Vedder, Edward B., and R. T. Feliciano, "An Investigation to Determine a Satisfactory Standard for Beriberi-Preventing Rices," *Philippine Journ. Science*, 35 (4): 351-389, 1928; Hermano, A. J., "The Nutritive Protein Value of Five Varieties of Rice," *Philippine Journ. Science*, 51: 567-572, 1933; Sreenivasan, A., "Nutritive Value of the Protein and Mineral Constituents of Rice Varieties," *Cereal Chemistry*, 19 (1): 36-47, 1942; Sreenivasan, A., and V. Sadasivan, "Nutritive Value of the Protein and Mineral Constituents of Dry and Wet Rices," *Cereal Chemistry*, 19 (1): 47-55, 1942.

⁵² Albrecht, 1944.

⁵³ Roschewicz, 1931.

243 he maintains that conditions favor mass mutation, and where he believes that such mutations have been utilized by rice growers since ancient times.⁶⁴ At any rate, and most likely in Africa, a number of the cultivated varieties have possibly originated from wild species such as *O. breviligulata*, *O. glaberrima*, and *O. officinalis*, which are related to *O. sativa* L. f. *spontanea*. The small-grained rice "very probably have taken rise from *Oryza minuta* Presl."⁶⁵ At least some of the multitudinous cultivated varieties could stem from the hybridization of these species with cultivated rice, the majority of which do owe their origin to *O. sativa* L. f. *spontanea*. The latter is referred to by Roschevitz⁶⁶ as a wild species; much of the literature does not specify it as wild, but lumps all cultivated rice as *O. sativa* L. Roschevitz⁶⁷ concludes:

The botanic-morphological and the botanic-geographical methods of investigation applied to the material available to us, lead us to the following conclusions: (1) our cultivated rice belongs to section *Sativa* Roschev., having for its center of origin tropical Africa; (2) by far not all the cultivated rice have originated from *Oryza sativa* L. f. *spontanea*; many of them have their origin from species akin to *Oryza sativa* L., as *O. breviligulata* A. Cheval. et Roehr., *O. glaberrima* Stend., *O. minuta* Presl., *O. officinalis* Wall., etc., either by way of being introduced into cultivation along with *O. sativa* L., or by way of hybridization with the latter; (3) the great varietal diversity of cultivated rice in India and Indo-China may be explained not only by the ancientness of rice cultivation in these countries, but also by the fact that wild rice *Oryza sativa* L. f. *spontanea* has found there suitable conditions for the production of a considerable number of mutants (which did not take place in Africa) and that these mutants have been introduced into cultivation.

The Asiatic origin of rice cultivation is equally confirmed by the multifariousness of the varietal material which in China, Indo-China and India, and in general the whole of south-eastern Asia, is immensely rich in varieties and races, while the number of varieties and races known for Africa is inconsiderable . . . that the cultivation of rice as a world-crop is due to China or to Indo-China, does not mean that rice did not thrive somewhere in the heart of central Africa, whose ancient history has remained a mystery to us, without having become known to ancient Egypt . . . As we know that rice was cultivated in Africa from the most ancient times, which is confirmed by the

⁶⁴ Jenkin Jones says concerning mutations:

"Mutations in rice probably occur much more frequently than was formerly supposed. . . . Most mutations in rice are recessive to normal. . . . on the basis of my observations over the past few years, mutations in rice, at least in this country, occur rather frequently.

"The rate of mutation no doubt depends upon the environment and the varieties of material grown. This also is true with respect to the extent of natural crossing between varieties, which also is more common than was formerly expected. These two factors, mutation and natural crossing, have no doubt been very active in the origin of the numerous varieties of rice present in Asia. . . . I am certain that the plant produces a greater number of varieties under domestication than in the wild."

⁶⁵ Roschevitz, p. 123.

⁶⁶ *Ibid.*

⁶⁷ *Ibid.*, pp. 123 ff.

fact that Africa, as we have seen above, possesses varieties of its own, grown from local wild rices, the question where wild rice was first introduced into cultivation remains unsolved. 243 ●

Though there are many more recent discussions than that of the Russian botanist, none consulted takes in as wide a range of material with comparable care. It is interesting to note that Roschevicz,⁶⁸ at least in the English summary of his text, makes no point of the physiological adaptations that lead agronomists to distinguish "wet" or "lowland," and "dry" or "upland," and deep-water rices. Parnell,⁶⁹ with the Indian botanists Ayyangar and Ramiah, remarks the existence of probably several thousand varieties of rice in India, and finds that the characteristics in which they differ are extremely varied, some being morphological and others physiological. Cross-fertilization would account for some of this great number of varieties. Burkhill is cited by Pelzer⁷⁰ as giving a polyphyletic origin for cultivated rice; *O. fatua* Koen. and *O. minuta* Presl. probably ancestors of *O. sativa* L.

Disregarding its botanical identity, the literature persists in classifying rice according to the methods employed in its cultivation. As to the "dry" or "upland" rice, the wide practice of shifting cultivation in conjunction with the cutting and burning of forest jungle or brush previous to cultivation may have helped to obscure the variant methods employed. This general practice, under such blanket designations as "jhum" (India), or "the milpa system" (Middle America), is used and abused in regard to its own variations, as well as in loose descriptions of the methods of rice cultivation. In Korea, where the technique has great antiquity, the Chinese refer to it as "fire field" agriculture. Common in southeast Asia, its historical connection with the development of rice cultivation has interested others than anthropologists. Pelzer⁷¹ treats it elaborately, and semi-popular works like Bruno Lasker's⁷² make the anthropologist desire a more careful understanding of the whole problem. Here, shifting cultivation is pertinent only insofar as it is one of the techniques employed in rice cultivation.

Chinese methods of rice cultivation were first widely discussed by French agronomists, whose practical interests led them there a hundred years ago. They also used the terms "wet" and "dry" rice. They were interested in introducing new varieties into the Midi, and for over forty years the Bulletin de la Société Zoologique d'Acclimatation buzzed with discussions of "le riz sec de Chine." Notable among these is the account by E. H. de Méritens,⁷³ who

⁶⁸ Roschevicz, 1931.

⁶⁹ Parnell, Ayyangar, and Ramiah, 1917-1922.

⁷⁰ Pelzer, 1945.

⁷¹ Ibid.

⁷² Lasker, 1944.

⁷³ De Méritens, 1855.

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translated sections of a Chinese encyclopedia of agriculture, the Shou-shih T'ung-Kao, a work completed in 1742, and based on the H'su-Kuang-chi, which was compiled from original manuscripts and edited by one Ch'en Tzu-lung, on imperial orders. M. de Méritens,⁷⁴ writing in 1855, credits Leon d'Hervey Saint-Denys with the first interest in "le riz sec" among his countrymen. Baron d'Hervey Saint-Denys, in 1850, published "*Recherches sur l'agriculture et l'horticulture des Chinois*." As early as 1842, however, S. Julien⁷⁵ in a communication addressed to l'Académie des Sciences described "le riz que se culture à sec dans la Mongolie," and referred to the same Chinese source used by de Méritens.⁷⁶ The Shou-shih T'ung-Kao gives a classification based not only on methods of cultivation, but on the period required for the maturation of rice varieties. It accounts for two main groups of rice cultivated in China besides "le riz aquatique."

TABLE I. CHINESE VARIETIES, ACCORDING TO THE
SHOU-SHIH T'UNG-KAO

Variety	Date Sown	Date Harvested
I. Sien-tao, or early rice, including:		
1. Lou-che-ji-tao, or 60-day rice ⁷⁷	April 5	June 5
2. Pe-ji-tao, or 100-day rice	April 5	July 5
3. Ta-sien, a large-grained variety	May 5	Early September
4. Siao-sien, a small-grained variety	April 5	August 5
II. Kang-tao, or late rice, including:		
1. Hanno		
2. A two-crop variety:—		
Crop one.....	March 21 to April 5	Summer
Crop two.....	Fall	Winter

Besides Sien-tao and Kang-tao, there is Ho-tao, or "riz de feu," suggestive of the "fire fields," but according to the source it was so called in China from its origin in the southwestern mountains, where the climate is hot and where rice is grown under difficult conditions from a Chinese standpoint. Suggestively again, fire fields are found today in the southwest. Ho-tao is transplanted in

⁷⁴ *Ibid.*

⁷⁵ Julien, 1842.

⁷⁶ De Méritens, 1855.

⁷⁷ Jenkin Jones comments here: "Unless it refers to a period from the time of transplanting, it is probably like our Sixty-day or Kherson oats which mature in 90 to 100 days. . . . In this connection, too, some of the authors quoted may refer to Ratoon crops of rice, that is, a second crop from one planting as the result of tillering under favorable conditions following the harvest of the first crop. Rice of this nature can mature in 60 days."

China now, but in olden times this was not done. It includes varieties that vary²⁴³ in shape, color and size of grain, and in consistency. Some varieties are fragrant. In Fukien, a plant known as "riz de Cochinchine" is cultivated on the uplands; this Julien⁷⁸ considers the best of all of "le riz sec." For one variety he gives the period of growth and maturation as 50 days; others maturing in 60, 80, and 100 days, in the main being harvested in August and September. This corresponds with the time given for Sien-tao. Julien⁷⁹ describes another "dry" rice from Jehol, a sample of which he sent to Paris, informing l'Académie des Sciences that it requires neither natural nor artificial irrigation.

The Shou-shih T'ung-kao, and a Chinese agriculturist of note, one Si-Hien-Tchong, relate how the Emperor Chin-Tsoung (A.D. 996-1021), to alleviate famine in eastern and western Chekiang, ordered the purchase of 30,000 bushels of drought-resisting rice from Fukien, distributing it to the poor people to plant under the instruction of his inspector of transport for grains. Again in the Sung Dynasty, Kiang-Ngao, a subprefect in Jouou-Tcheou, sent to his native Kien-ngan for drought-resisting rice to relieve famines, and thus introduced it to the uplands of the north Chinese valleys. This rice was found to yield abundantly, by local standards at the time. According to the encyclopedia both Sien-tao and Kang-tao were introduced from Cochinchina. The two groups differ in certain physical properties: Sien-tao is the smaller, brighter grained, and is nonglutinous. Kang-tao is sometimes bearded, includes glutinous varieties, and is found in many colors of awn, while Sien-tao is either red or white.⁸⁰

The Chinese method of cultivation for "dry" rice, as given in the source, is different from that used for the "wet" rice. For "dry" rice the nurseries are tilled once in preparation for the seed, which previous to sowing is soaked for one night in water to hasten germination. Seed is not sown broadcast, but in small holes, a few grains to each; wet ashes, the product of burned plants or rice straw, are spread over the whole area sown; the nurseries are weeded three times, and subsequent to each weeding liquid manure is scattered on them. By this time the blade is above ground, and grows with great strength and rapidity. "Le riz sec" is said to thrive equally well on the plains or in the mountains. De Méritens⁸¹ gives another method for its cultivation. Before sowing, the soil is moistened and manured thickly, sometimes with oil cakes, sometimes with

⁷⁸ Julien, 1842.

⁷⁹ *Ibid.*

⁸⁰ Jenkin Jones states in regard to this: "There are two kinds of rice based upon the nature of the endosperm—nonglutinous, which is grown most extensively, and glutinous (waxy). Both may be bearded or beardless, early or late, of poor or good quality, and have red, purple, brown or white bran coats. Kang-tao apparently was a mixture of nonglutinous and glutinous types similar in appearance and color, for rice, like other plants, does not change from one form to another except through hybridization and mutation."

⁸¹ De Méritens, 1855.

243 leaves and the bark of trees, in addition to animal manures. For the preparation of hard soils brushwood may be gathered and burned, and then plowed under. The rice is transplanted when it is about 20 cm. high. The fields in which it is set out must not be inundated, nor too dry. For "le riz sec," as for "le riz aquatique," the soil is usually prepared in spring. M. de Méritens²² notes the greater labor involved in transplanting the latter. He draws on d'Hervey Saint-Denys for his information here. The main fields, after tilling, are flooded to receive the transplanted seedlings. First the laborer and his oxen tread the submerged mud, puddling it to a depth of 15 to 20 cm. The plow is not used in this process. The field is then harrowed to level it, and flooded again. The rice is then transplanted from the nurseries to the inundated fields, its roots immediately covered with mud by the action of the water. The roots are planted in holes prepared after the field is flooded, and just when the plants are being set out in rows. It goes without saying that transplanting to unsubmerged fields is less work.

In contemporary accounts there is unanimity on the fact that most Chinese rice is transplanted,²³ but there is less detail as to varieties. Wagner²⁴ gives "den gewöhnliche Wasserreis," "den sogenannten Bergreis," and "den Klebreis" (glutinous), but fails to distinguish methods of cultivation. His "mountain" rice ripens in four months, and his "water" rice (irrigated) subdivides into early, medium and late varieties. John L. Buck²⁵ describing land utilization in China, gives regional differences in agricultural techniques. In the Yangtze region, the slopes are terraced above the flood plains. In the southwest, terraced fields occupy fifteen per cent of the area cultivated, and some of the Lolos and Miao grow rice on terraced land. Szechwan is a frostless area where a spring crop is grown in addition to the main one, and is the only part of China where the soil is rich enough not to need fertilizers, although they are used to some extent. In what Buck²⁶ designates as the "rice-tea" area, much of which is hilly, the bottom lands are planted in rice. R. H. Tawney²⁷ remarks the use of "water farming" in the Yangtze region, and in the south, where double cropping of rice is a regular practice, together with more intensive cultivation. George Cressey,²⁸ like Buck,²⁹ divides China into agricultural regions. He blames the poor soil and the limited supply of water for the scanty planting

²² *Ibid.*

²³ See: Martin Yang, 1945, *A Chinese Village. Taitou, Shantung Province*, pp. 22-23. The rice is sown in small holes, after plowing; it is not transplanted or irrigated; in a considerable area around Taitou no rice is grown. Fertilizers are employed, including ashes mixed with dung.

²⁴ Wagner, 1926.

²⁵ Buck, 1937.

²⁶ *Ibid.*

²⁷ Tawney, 1932.

²⁸ Cressey, 1934.

²⁹ Buck, 1937.

of rice in northern China, stating that it can be grown as far north as Vladivostok: He summarizes: 243

The most conspicuous boundary is the northern limit of continuous rice cultivation, with its flooded fields, canals and water buffalo, near latitude 33° North . . . this line lies midway between the Yangtze and Hwang rivers along the crest of the Tsingling in the west and near the Hwai River in the east. South China is a green, humid, subtropical riceland, while the north is a dry brown wheatland under the influence of the desert . . . Major contrasts appear between the wheat and rice provinces . . . The growing season in north China is five to eight months, while in south China it is ten months to a year, so that double cropping is more widespread and the same land can support more people. Rainfall is over twice as heavy in the south. The gross area of the south is larger but the presence of extensive plains in the north gives it a greater cultivated area. Nevertheless, the higher productivity of the rice lands enables them to support nearly twice the total population of the wheat-producing section.⁹⁰

The Yangtze Valley is subject to the hazards of over-flooding and droughts, but the rice crop usually stands to benefit by the three-month flood period. This region yields one rice crop annually.⁹¹ Terraces occupy the south Yangtze hills. Two, and sometimes three crops of rice per year are grown in southern China, where the yield per acre is second—in Asia—only to that of Japan, and is three times that of all India or Java. The lower and central Yangtze and the western and southern area of China lead in rice production. In the Canton delta the first crop is set out in March and harvested in July; a second crop is then transplanted to the main fields to be harvested in November. In eastern Chekiang an early crop is harvested in July, a late crop in October. Terraced lands are cultivated mainly in Szechwan, especially on the slopes of its Red Basin. Agriculture is most intensive in southern China, where the double cropping of rice is the regular practice. On the southwest tableland, rice is the dominant summer crop; it is often dependent entirely on rain for its water supply, excepting in the mile-high plateau, where flooded fields prevail. A description of Yunnan, edited by H. T. Fei,⁹² notes that the southwest tableland and the valleys are diverse in both crops and population; here begins the altitudinal stratification of peoples and cultures that is so very characteristic of Farther India. The Lolos adhere to maize as their staple, growing some rice on terraced land. The Chinese immigrants grow mostly rice. They prepare the land in April, and bring off the crop in autumn.

⁹⁰ Cressey, 1944, pp. 91-93.

⁹¹ Jenkin Jones notes: "In much of the Yangtze Valley and from Central Japan to the southern part only one rice crop is grown a year but the land is double cropped, wheat, barley and vegetables often being the second crop. In this connection, N. Jasny, in his *Competition among Grains*, Stanford University, 1940, p. 7, explains: 'Where the cool season is too cold and/or too dry for rice, fall-sown wheat or barley is frequently rotated with it on the same land and in the same crop year'."

⁹² Institute of Pacific Relations, 1943.

243 These few surveys are fairly compatible with that of the Shou-shih T'ung-Kao. The practical universality of transplanting in China is worthy of a remark. It has been demonstrated by agronomists that transplanting increases the yield per plant and per acre.⁸² The seedling develops new grain-bearing tillers when it is transplanted, so that even double transplanting⁸⁴ has been found rewarding.⁸⁵ It economizes seed: in China one acre of nursery seedlings plants from ten to twenty-five acres of rice; and it permits double cropping, the second rice crop getting its start in the nursery while the first crop of rice, or in some cases another plant, as wheat or barley, matures in the field.⁸⁶ Transplanting can mitigate the dangers of drought and flood in the main fields by delay until favorable conditions return. In India and in the Philippines the rice transplanted is sometimes raised in a dry-farmed nursery.

Tanaka and Yekoussima,⁸⁷ writing in 1867, describe "dry" rice grown in Japan. The plant needs a certain amount of water, but it is not grown on flooded fields. In Jeddo (Yeddo) it is planted in March and harvested in October or November, at the same time when the irrigated rice is taken off.

⁸² Jenkin Jones interpolates here: "This is true in some tests, not so in others. Transplanting does save seed, irrigation water, makes the crop easier to fertilize and weed, and to double crop. These and not increased yields account for the practice in Central Japan and the Yangtze Valley."

⁸⁴ Hedayetullah, 1943.

⁸⁵ Jones says, to the contrary: "Tillering is associated with the variety, the conditions under which the rice is grown, spacing, number of plants per hole, climatic conditions and other factors, and if rice is transplanted rather close together you get essentially the same amount of tillering as if you had sown directly at the same spacing. That transplanting does not necessarily result in high yields is evident from the fact that much of the rice crop is transplanted in the Philippine Islands, Indo-China, Siam, Burma, and India, but the average yields in these countries are relatively low, ranging from 22 to 36 bushels per acre in the pre-war period; whereas, in California, Italy, Egypt, Spain, yields often range from 60 to 75 or 80 bushels per acre without transplanting."

⁸⁶ F. H. King, *Farmers of Forty Centuries*, Madison, Wis., 1911, includes increased yields in the benefits due to transplanting, to wit, p. 284: "Extensive as is the acreage of irrigated rice in China, Korea and Japan, nearly every spear is transplanted; the largest and best crop possible, rather than the least labor and trouble, as is so often the case with us, determining their methods and practices." *Ibid.*, pp. 288-289: "More than a month is saved for maturing and harvesting winter and early spring crops, or in fitting the fields for rice, by this planting in nursery beds. The irrigation period for most of the land is cut short a like amount, saving in both water and time. It is cheaper and easier to highly fertilize and prepare a small area for the nursery, while at the same time much stronger and more uniform plants are secured than would be possible by sowing in the field. The labor of weeding and caring for the plants in the nursery is far less than would be required in the field. It would be practically impossible to fit the entire rice areas as early in the season as the nursery beds are fitted, for the green manure is not yet grown and time is required for composting and for decaying, if plowed under directly. The rice plants in the nursery are carried to a stage where they are strong feeders and when set into the newly prepared, fertilized clean soil of the field they are ready to feed strongly, under these most favorable conditions. Both time and strength of plant are thus gained . . . the best possible practices under their condition of small holdings and dense population."

⁸⁷ Tanaka and Yekoussima, 1867.

Remote from the main rice fields, it is grown on hill slopes where, when the summer is very hot, the Japanese have means to irrigate it. Before it is planted the ground is enriched with night soil. The seed is prepared by soaking for three days in water and then exposing to the sun. When sown it is mixed with ash and powdered fish refuse and scattered in furrows. It is subsequently weeded and cultivated. Transplanting is not mentioned in connection with this crop.

R. B. Hall⁹⁸ assigns only local importance to "upland" rice in Japan, where it now occupies in all 206,500 cho. In order of importance, the main producing areas are: the diluvial terraces of Kwanto, the dry central part of the Taiwan plain, and the ash plateau of southern Kyushu. A little is grown in Ou, the northernmost district of Old Japan, where the growing season is short and the climate relatively cold. The diluvial terraces of Kwanto have a "... cool, moist sprouting season and ... a hot, dry ripening period."⁹⁹ In Hokkaido the growing season is short, "upland" rice is not cultivated, but quick-maturing "lowland" varieties have been established. Rice cultivation is only a recent development on the island, and the northern limit is set by a 90-day growing season. No altitudinal limit is mentioned for the Japanese islands. In Tokai, the East Sea district, there is "... irrigated rice on the delta plains and specialized dry land production on the terraces. ..."¹⁰⁰ A variety known as "Izumo" is grown in San-in and along the Sea of Japan coast, a relatively cool region with a short growing season, where there is little level or arable land; we are left in doubt as to whether this is an "upland" variety of rice. Double cropping of rice, wheat, barley, and other crops is practiced in northern Kyushu (Kita), in southern Taiwan, and in the Nanki, Setouchi, and Tokai districts of Old Japan. The Hokuroku district, situated in the west central plains south of Ou, embraces "... the most specialized paddy areas in Japan."¹⁰¹ The Kwanto plain produces almost as much "paddy" as Hokuroku and more than half of the "upland" rice crop of Japan. In the Imperial district of Kinai, the "... alluvial basin floors constitute vast paddy fields, and the average yield is the highest in Japan."¹⁰² In Kinai a few terraces are cultivated.

In Korea, half the rice grown is dependent on rain for its water supply. In the north the growing season lasts only 100 days, the terrain is rugged, and "lowland" rice occupies a little over one tenth of the farm land. The north-eastern people, who are shifting cultivators, grow no rice at all, while in the northwestern section there is "... a relatively important production of 'dry'

⁹⁸ Hall, 1934, 1935.

⁹⁹ *Idem*, 1935, p. 133.

¹⁰⁰ *Idem*, 1934, p. 339.

¹⁰¹ *Ibid.*, p. 327.

¹⁰² *Ibid.*, p. 336.

243 rice.¹⁰³ As in the description of Japan, Hall¹⁰⁴ omits any mention of transplanting, though double cropping may be taken to infer it. He takes the southern boundary of Korea as the line separating modernized (Japanese) rice cultivation and double cropping from simpler methods employed with single cropping in the north. In southern Korea the growing season lasts 150 days, and a higher proportion of rice fields is irrigated than elsewhere.

The Malay Peninsula presents a wide variety of agricultural methods. Here the "wet" system obtains for ninety per cent of the rice fields:

But there are variations of both these main systems to suit local conditions: wet systems involving considerable preliminary cultivation as opposed to systems where cultivation is practically impossible owing to the soft nature of the land; dry systems which include both ploughing and raking, and a dry system which merely entails the clearing and burning the jungle in preparation for the crop.

In the cultivation of "wet" padi the general procedure (of course with local variants) is to plough or dig the land once or twice, and rake or smooth it with a roller. The seed is planted in a nursery and is ready for transplanting in the field after 40 days. The seedlings are planted three or more per hill, about one foot apart. After cultivation consists of weeding.

In dry padi cultivation the land is sometimes ploughed twice, raked and the seed sown by hand or drilled; or seed planted in clumps about a foot apart, or in hill cultivation, virgin land is cleared, burned, and the seed broadcast.

Generally speaking, manuring is not a common practice in padi cultivation. In Kedah and Perlis, where bat guano is easily procured, the land is periodically manured. In Kelantan a system exists in which each plant, after transplanting, receives a small application of burnt mixture of cowdung and earth, coconut and arecanut leaves. In parts of Perak and in Province Wellesley and Malacca, the seedlings are steeped in a mixture of mud, phosphate and ashes immediately after removal from the nursery.¹⁰⁵

In the Krian district of the Malay Peninsula, a floating seedbed is used. Weeds are cut, plastered together with clay, and piled in a long strip, to float as a platform on the surface of a flooded field, the top staying two inches above the water level. A thin layer of mud is applied to sow the seed in. The plot rises and falls with the water in the field, keeping the seedlings above water while their roots develop in the submerged layers. The seed is germinated prior to sowing by three days' soaking in water, and two more days in a moist condition. The germinated seed is broadcast on the nursery and a layer of leaves is put over it for ten days to protect it from the sun and from birds. In two weeks the plants are six to eight inches high. A similar nursery is used on the west coast of India. In the Malay Peninsula, the plants are set out first in clumps of 150 to 200, and partially submerged. At the second transplanting, ten days later, these clumps are broken into smaller ones that are placed in rows. Forty

¹⁰³ *Ibid.*, 1935, p. 48.

¹⁰⁴ *Ibid.*

¹⁰⁵ Malaya, Dept. of Agriculture, 1939, p. 42.

days later, at the third and final transplanting, the tops of the seedlings are cut back, and the roots are pruned and dibbled in. Two or three weeding take place after this. As soon as the plants flower, the water is gradually drained off the fields, to be gone when the grain has set and is ripening. The varieties that are planted in the best soil, in June, ripen in the short dry season early in the year, about February. The period of growth for irrigated rice may be said in general to last from seven to eight months. 243

In the district of Kelantan, "dry-land" nurseries are used for "wet padi." The site is plowed and harrowed twice, the seed broadcast thinly and harrowed in. Usually the single transplanting takes place forty days later, though adverse weather conditions may delay it as much as three months. The main fields cannot be cultivated until the July rains soften the soil. Preparation of the land and planting proceed from then until November, the low-lying areas being completed first, followed by the higher and drier areas. Plowing is not possible in all types of Kelantan soil. The transplanted rice crop is drained if there is an excess of rain. The crop is not weeded, but is manured as described above. In this district:

Two distinct types of padi are cultivated, namely wet padi or padi chedongan, and dry padi, padi tugalan. This dry padi must not be confused with the dry or hill padi, padi huma, found in various parts of Malaya, as the methods of cultivation are distinct.¹⁰⁶

Further:

The land planted with dry padi falls into two groups, that habitually under the dry crop and that which may be utilized for either the wet or dry type. The latter forms but a small proportion of the whole and comprises the lower lying dry padi, or tugalan lands, the choice of wet or dry padi for any particular year usually depending on the inclination of the cultivator. Generally speaking, the fields are flat or slightly sloping and in the latter case wet padi is found at the bottom of the slope, dry padi land over the main area and the intermediate or alternating type mentioned above in a narrow strip between the two.

The soil throughout the dry padi lands is markedly homogeneous and . . . a heavy loam predominates.

In view of the localized nature of the crop it is not surprising to find that there are only some twelve distinct varieties cultivated. The maturation periods of these varieties vary from 173 to 197 days and, though the majority can only be used as dry padi, there are some which can also be successfully planted on wet land.

The success or otherwise of the dry padi crop is dependent on a favorable monsoon. Dry padi calls for an amount of labor and care which is greatly in excess of that required to produce a crop of the wet type.¹⁰⁷

In Kelantan the dry season lasts from the middle of February until the end of May. After the early showers in July and August, the "dry padi" land

¹⁰⁶ *Ibid.*, pp. 48, 49.

¹⁰⁷ *Ibid.*

243 is plowed and harrowed four times, and the seed dibbled in lines, before the monsoon rains come. Land must not be plowed or weeded when too wet, since packing or puddling this soil injures the plants.

A simpler method, like the one called "padi huma" in Trengganu, is used in farming "dry-land" rice in Province Wellesley North. It consists in cutting and burning the standing vegetation, followed sometimes by a light hand-digging after the April rains; the seed is dibbled into holes and covered, with no subsequent care. In Trengganu, four types of rice are distinguished locally

- (1) Padi chedongan—"wet," transplanted rice.
- (2) Padi taboran—rice broadcast on non-irrigated land.
- (3) Padi tugal—rice dibbled into dry land.
- (4) Padi huma—rice dibbled in on burned off jungle land which is left to revert to jungle after one season's use.

The first is dependent chiefly on rain for irrigation. Type 3 is on the lines of the Kelantan "dry padi," described above. Type 2 is planted either because the owner knows no alternative method of cultivation, or because he has too much land to care for by the superior tugal method. Type 2 fields are plowed and harrowed three times; the seed is broadcast and covered with a harrow instead of dibbled in, and the crop is subsequently untended until harvest. The land is used and fallowed rotationally for type 2. Type 4 represents what some writers distinguish as true shifting cultivation: the fields are not re-used, new jungle being cleared and prepared annually.

In the Pahang district, after two or three crops of "dry padi," newly reclaimed land is often planted permanently with crops other than rice. Methods here are "... the most primitive of any of the four Federated Malay States." "Wet padi" is sown in nurseries in February and March, harvested in December and January. Planting periods vary with local seasonal differences. Pahang crops do not depend completely on rain water. Nurseries:

... for any types of "wet" cultivation are usually situated, on dry land. . . . Secondary jungle is usually selected, felled and burnt shortly before sowing the seed. A few larger trees are usually left to afford light shade. The seed, previously soaked in water, is broadcast after the soil has been lightly cultivated, the area then raked to bury the seed. A small amount of weeding is done later if necessary and in the event of dry weather the beds may be watered. . . . The seedlings remain in the nursery for six to seven weeks, or much longer if weather is unsuitable for transplanting.¹⁰⁰

"Wet padi" land in Pahang is locally differentiated as: (1) Paya, or natural swamp, subdivided into that which is at least partially fed by a stream, and that fed by rains alone; (2) Paya sawah, or artificially irrigated, often flat land, not always swampy; it may include terraced land, and most of it is provided with some form of water supply. Three methods are given for cultivating these two types of "wet padi" land. One involves transplanting, and is like Type 1

¹⁰⁰ *Ibid.*, p. 56.

above in Trengganu. The standing grass is cut and left to rot. The soil may be worked by hand, or plowed. Sometimes "... buffaloes are employed to trample the grass on the paya and puddle the soil."¹⁰⁹ A second method includes presoaking the seed for two nights. The land is prepared as above, and the seed broadcast. A third method is attributed to the Sakai, many of whom live upstream on the main rivers. Virgin or secondary jungle is cut and burned in the dry season, the land then cultivated for two or three years successively. The moist seed is sown broadcast on the semi-wet swamp land (paya), after the rains begin. Crops receive no further care.

In areas marginal to mainland Asia, the evidence is that practice runs as wide a gamut as in the Malay Peninsula. For Madagascar we have Linton's¹¹⁰ account. Mainland Africa, though having both "wet" and "dry" farming of rice, is not considered here. Going from Madagascar to the Philippines,¹¹¹ the Indonesians are found farming rice by both the "wet" and "dry" systems. The Philippines, best known for their elaborate terraced areas, include tribes that farm dry only with shifting cultivation, tribes that use both this and terracing with irrigation, and tribes that irrigate without terraces. In Java¹¹² and in Madura "upland" rice is grown on non-irrigated terraced land, besides the "wet" rice of the terraced and dyked flat lands. Shifting cultivation and dry farming obtain in the Lesser Soendas. Celebes farms rice by both irrigated and non-irrigated methods. So does Borneo:¹¹³ the Dusuns and Muruts irrigate, the Dyaks elsewhere usually plant with the seasonal rhythms of the monsoons and rely on rain water.

Farther India presents varied environmental conditions; thus it is not surprising to find Estèbe¹¹⁴ describing for Tonkin, Annam, Cambodia and Cochinchina these diverse groups of rice:

TABLE II. FARTHER INDIAN VARIETIES, AFTER ESTÈBE

<i>Variety and Method of Cultivation</i>	<i>Date Sown</i>	<i>Date Harvested</i>
1. Early rice. Transplanted once, in July, it matures in four to five months. It is cultivated on small fields for home use. It is hard to harvest because the rains come when it is ripe.	April	October

¹⁰⁹ *Ibid.*, p. 57.¹¹⁰ Linton, 1933.¹¹¹ See: Bartoli, 1930; Christie, 1909; Cole, 1922; Garvan, 1941; Jenks, 1905; Pendleton, 1942; and Pelzer, 1945.¹¹² See: Cole, 1945; Koch, 1930; Pelzer, 1945; Van Eerde, 1937; Van Valkenburg, 1935; and Wickiser and Bennett, 1941.¹¹³ See: Elshout, 1926; Hose and McDougall, 1912; and Rutter, 1929.¹¹⁴ Estèbe, 1934.

- 243 2. Midseason rice ("Riz de demisaison"). It takes six months to mature. Grown on high and intermediate fields—high ones depend on rains. Highland varieties are grown much in north and east of Cochinchina, and on high fields in Cambodia during the rainy season. June to July December to January
3. Main crop ("Riz de saison"). Some varieties are transplanted once, some twice. It takes seven to eight months to mature. Grown on flooded and the richest alluvial soils; main crop on low fields of deltas and coast—some varieties are salt-tolerant, tides visit twice a day. Some 700 varieties grown in Indochina. Manures are much used. Rain-fed varieties are grown on high fields. June to July January to February
4. Twice-transplanted rice. Matures in nine months. Transplanted first in August, and again in October–November. June to July February to March
5. Floating rice.¹¹³ Not transplanted. Grown in lake and delta regions, especially in Cambodia and Cochinchina. The seed is broadcast before the rains, the field cultivated once. Keeps on growing after floods, in depths c. three meters. When floods subside, the plants collapse, develop new roots and raise themselves, then flower and mature rapidly. End of April December to January
6. Post-flood rice. A secondary crop. Transplanted from highland nurseries to the banks of streams after the floods subside. Flowers in February–March, then matures rapidly. Sown on less productive lands after their main crop is off. It is being replaced with floating rice. October to November March to April
7. Two-crop rice:
- | | | |
|----------|-------------|---------|
| Crop one | May | October |
| Crop two | End of June | — |
- Crop two is transplanted in October to fields just harvested. Two-crop varieties are rare; they are grown in the Tonkin delta, and in Annam and Cochinchina. Some, on the coast, are salt-resistant.

¹¹³ Jenkin W. Jones comments: "Some varieties or types of rice are restricted to certain areas, including the so-called 'floating rice,' because of environmental conditions. The outstanding characteristic of floating rices is that they are able to grow rapidly as the water level rises, and hence, to survive. As a group, floating rices are relatively unimportant except in limited areas where, owing to floods, the usual types cannot be grown."

Most of the rice is intermediate in its water requirement between the floating rice and the "riz de terrains sec," but does require a plentiful supply. Here, as in China, there are some varieties said to be of Siamese origin. Double cropping is rare in Cochinchina. 243

Estèbe¹¹⁸ notes that "upland" varieties are grown to a great extent in northern and eastern Cochinchina, in the Mekong region, and in Cambodia on the high fields. In the Mekong delta and elsewhere, such fields are dependent on rain for water supply, and it is sometimes retained in ditches in the Mekong region. These remarks are interesting in view of the Chinese account of rice introduced from Cochinchina. Chevey¹¹⁷ gives an interesting account of the floods of the Tonle Sap, where floating, or deep-water, rice flourishes.

Van Valkenburg's¹¹⁹ classification of rice in Farther India supplements Estèbe's,¹¹⁸ but does not conflict. His includes: For Cambodia and Cochinchina, a floating rice (sometimes transplanted before the floods), and a dry season or post-flood rice; on the coasts of Annam, an "eighth month" rice and a "tenth month" rice; for the Tonkin delta, in addition to the two last named, a "twelfth month" rice, which includes "lowland" and "upland" varieties, and a "fifth month" rice, including the same, and also a two-crop rice. He allots the irrigated rice of Annam to the coastal plains and fertile valleys, the Tai in the upland valleys raising it also. Pierre Gourou's¹²⁰ survey of the Tonkin delta gives a "fifth month" rice, covered by deep water in summer, grown on the lowest lands, including salt-tolerant varieties, and harvested in June. He parallels Van Valkenburg¹²¹ with an "eight month" rice that is harvested in September, and a ubiquitous "tenth month" rice, harvested in November. He mentions a "dry" rice harvested in September along with the "eighth month" rice. In the Tonkin delta, the two-crop rice is the most extensively cultivated. The second crop, in the nurseries during September, is weeded and irrigated while the first crop flowers and matures in the fields. There is also a "rice of three moons," that is reaped in August. The "fifth month," "tenth month," and two-crop rice are all intensively cultivated and grown in irrigated fields where the soil is periodically aerated and kept thoroughly manured.

Among the Karen¹²² of Burma, the hill people plant, cut, and burn the upland fields; the lowlanders plow, harrow, puddle with buffalo, and plant nurseries, transplanting to flooded fields. Credner¹²³ makes a contrast in the methods of the Tai, who live where irrigation is possible, and those of their neighbors in the hills—Lolo, Lissu and Minchia, whose agriculture is "many-sided." Maltre¹²⁴ mentions "les hommes des rizieres," or of the "wet" rice fields, among the Moi; J. H. Hoffet¹²⁵ lists tribes of Moi who plant "rizieres" and those who plant "rai," or fired upland fields. Charles Robequain,¹²⁶ men-

¹¹⁸ Estèbe, 1934.¹¹⁷ Chevey, 1934.¹¹⁹ Van Valkenburg, 1933.¹¹⁹ Estèbe, 1934.¹²⁰ Gourou, 1936.¹²¹ Van Valkenburg, 1933.¹²² Marshall, 1922, pp. 67, 88, and pl. opp. p. 82.¹²³ Credner, 1935.¹²⁴ Maltre, 1922.¹²⁵ Hoffet, 1933, pp. 8-29.¹²⁶ Robequain, 1939, p. 74.

●243 tioning unspecified back-country tribes in Indochina, makes the same distinction. Paul Palté¹²⁷ says that the hinterland Moi lack "les rizieres Annamites." Virginia Thompson¹²⁸ differentiates between the main crop and the fast-growing rice varieties in Siam. Zimmerman¹²⁹ details the local differences in practice among the Tai, and mentions several rices that mature in three, four, and five months in northeastern Siam, while in the south a few people grow "upland padi," but most rice is transplanted. Double cropping is rare here, and so are the refinements of southern Chinese rice culture, especially manuring.

In Assam, as wide a variation of practices exists as we noted for the Malay Peninsula. One nucleus of such variations clusters around a general pattern of shifting upland cultivation, here including terracing, and excluding the use of buffaloes and the plow. The wide altitudinal range of climate puts emphasis on suitability of the varieties planted to the particular locale. The Angami Nagas exemplify this situation. To cite Hutton:¹³⁰

The rice grown in wet fields is of several varieties, some sorts being suitable to low and hot situations, and others doing better in cold and high fields. The varieties differ also in the time taken to mature.

His "wet" rice refers to artificial irrigation. Though he lists native-named varieties, Hutton¹³¹ employs "dry" and "wet," as:

In some villages . . . terraces built for jhum . . . [are] almost as elaborate as those made for wet cultivation.

"Jhum" refers to the fire fields. The dry-farmed (non-irrigated) land gets good care. Seven of the native-named varieties are dry farmed, though one of these is grown also on irrigated terraced land. Mills,¹³² in describing the Lhota, enumerates twelve native-named varieties of rice. In the Konyak villages, according to Fürer-Haimendorf,¹³³ the fields are non-irrigated; he makes no mention of rice varieties. Leaving the Nagas, we find the Lakher sowing their lightly hoed fields in April, the seed left exposed for rain to cover. They weed two or three times, and begin their harvest in October, pulling up the whole plants! Parry¹³⁴ gives fourteen native-named varieties with soil preferences, some maturing as late as December and January.

Cultivation in India may be equally diversified, but the material is more difficult of access. For Bengal, Hedayetullah¹³⁵ gives a five-fold classification, based upon methods of cultivation and season of growth. Thousands of varieties fall within these well-marked agricultural groups, which include some that are indistinguishable morphologically, but are physiologically distinct.

Sarat Chandra Roy¹³⁶ gives a good account of cultivation for the Oraons of Chota Nagpur. Other reports may be given: Grigson¹³⁷ describes the Maria

¹²⁷ Palté, 1906, p. 220.

¹²⁸ Thompson, 1941, pp. 354-357.

¹²⁹ Zimmerman, 1931.

¹³⁰ Hutton, 1921, p. 76.

¹³¹ *Ibid.*

¹³² Mills, 1922.

¹³³ Fürer-Haimendorf, 1939.

¹³⁴ Parry, 1932.

¹³⁵ Hedayetullah, 1946.

¹³⁶ Roy, 1915.

¹³⁷ Grigson, 1938.

TABLE III. BENGAL VARIETIES, AFTER HENAYETULLAH

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<i>Variety and Method of Cultivation</i>	<i>Date Sown</i>	<i>Date Harvested</i>
1. Early rice. Not transplanted. Grown on the highlands. Sown broadcast. Dependent on rain for water supply, and not ordinarily grown in flooded fields.	April to May	July to September
2. Winter rice. Transplanted into flooded fields in July and August. This constitutes the main crop.	June to July	October
3. Lowland rice. Not transplanted. Grown on low bhil lands. Sown before the heavy rains. Harvested in standing water, it grows in depths to six feet.	February to March	July to August
4. Floating rice. Not transplanted. Grown on the lowest floodlands. Sown broadcast before the rains. Collapses and reroots when the floods recede (as described by Estèbe in Farther India). Grows in depths to thirty feet, keeping the top above water.	February to March	November to July
5. Post-flood, or spring rice. Sown in nurseries and transplanted to river banks when the floods subside, or to lowlands that retain moisture throughout the winter. Sometimes irrigated.	October	March to April

Gonds of Bastar cultivating "light mountain rice," which produces three crops: early, main, and late. Some Mariās are shifting cultivators, some have the beginnings of permanent cultivation with irrigation. The Hos in Kolhan¹³³ plow and transplant; when the land is hilly, they sometimes terrace it. Elwin¹³⁹ gives the Baiga sowing "upland" rice on fire fields, with hand tillage and water supplied by rains. Grierson¹⁴⁰ reports 60-day rice in Bihar, which is rain fed; other kinds are transplanted here, once or twice; these varieties mature at different periods from July through December. In the Konkan, on the west coast of India, Ranade¹⁴¹ reports painstaking farming from the village of Roth Khurd. This is a fertile region where rain is abundant. Most of the rice grown here belongs to early varieties that are sown in May, after the rains set in, and are harvested in October. This rice is locally called "hali." All of the fields depend on the monsoon rains for their water supply. The rice is transplanted. Nurseries are tilled by hand, and elaborately fertilized, first with a dressing of

¹³³ Majumdar, 1937.¹³⁹ Elwin, 1939.¹⁴⁰ Grierson, 1926.¹⁴¹ Ranade, 1927.

243 dung which is covered with grass and branches, then with fine dust, and on top of this with liquid manure. This preparation is made to ensure slow combustion. Then the whole field is fired in April or May, and is ready for sowing. The nursery is hastily plowed before the rains set in, and the seed is broadcast on it. If the monsoon rains hold off, the plot is irrigated. With regular rains, the plants are a foot high in two weeks. The main fields are prepared by several light plowings, and after they are flooded the seedlings are transplanted to them. The plant tops reach above the water, and their roots become established in about two weeks. The fields are drained occasionally and weeded, and by harvest time are drained completely dry.

Ethel Simkins,¹⁴² in a geographical survey of rice cultivation on the coastal plains of south India, finds that on the western coasts rice is grown the year around, as it is in Java. This does not hold true for the Madras coast, though the spring rains there do allow an early-season crop to be cultivated. The west coast, having dependable rains, needs little irrigation, whereas a large percentage of the east coast is irrigated. In the deltas, rice is grown on "wet paddy" land. Where the fields are irrigated, three crops a year are sometimes grown. The main crop relies on rains.

The "lowland" varieties are always transplanted; the "upland" rice is sown broadcast . . . [it is] a poor and coarse-grained variety, usually grown unirrigated.¹⁴³

Wickizer¹⁴⁴ likewise remarks great variety in Indian agricultural practice.

In Asia the descriptions of rice cultivation have been over-simplified in the literature. Actually no sharp division in agronomic practices exists between the more and the less sophisticated peoples. The transitions between the methods employing irrigation and dry farming are too numerous to justify the continued use of "wet" and "dry." Classifications according to habitat, as "upland," "lowland," "mountain," and "swamp" are useless because the plant adapts so readily to varied environments. In comparative work and historical reconstructions such terms alone are inadequate.

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¹⁴² Simkins, 1933.

¹⁴³ *Ibid.*, p. 36.

¹⁴⁴ Wickizer and Bennett, 1941.